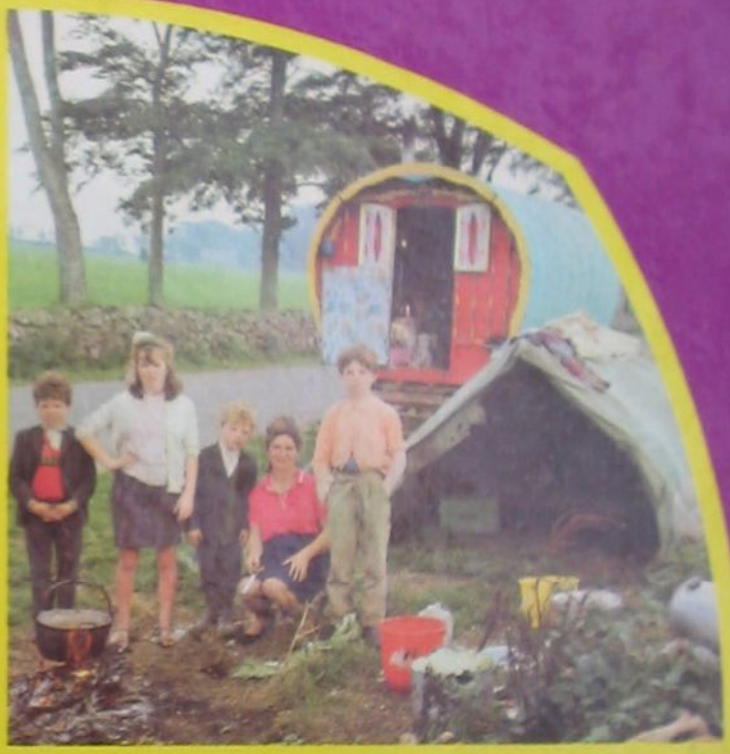
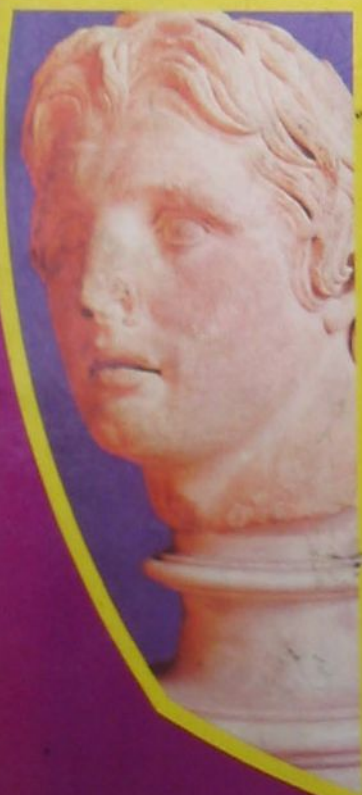
New Junior Encyclopedia

Vol 8 gog .fce





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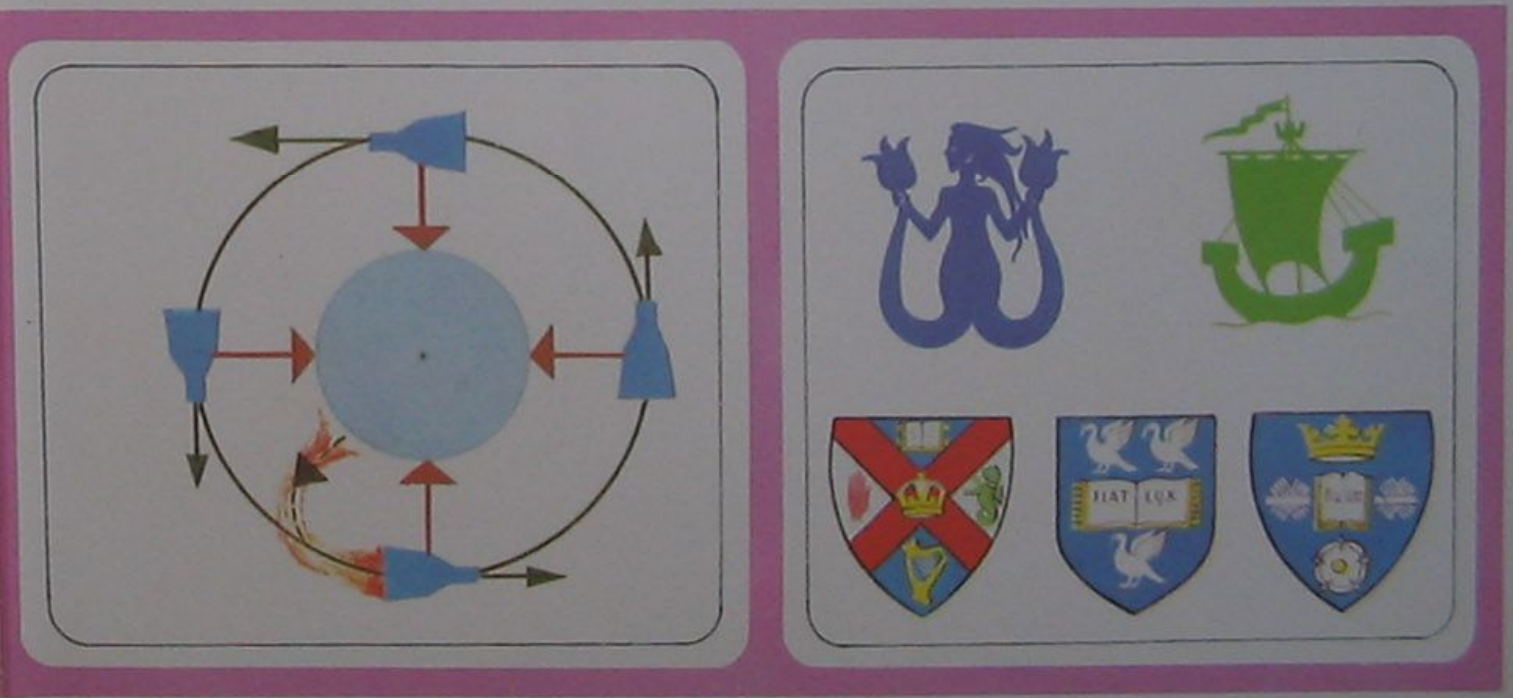


A Greek shepherd in national dress.

A landscape painting by Vincent van Gogh. It is called 'A field of corn with a cypress tree' and shows his expressive use of brush strokes to portray movement.

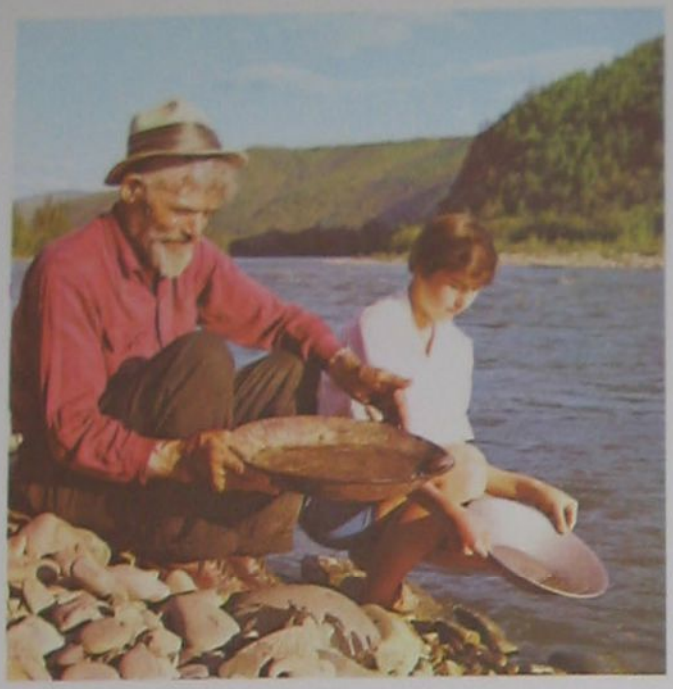
Gogh, Vincent van (1853-1890), a Dutchman, was one of the greatest painters of modern times. His most famous works, painted during the last four years of his life, are known for their brilliant colours and their thick, rhythmic brushstrokes. He painted portraits, landscapes and *still life* (inanimate objects).

Van Gogh was born in Brabant, in the south of the Netherlands. He worked for a while as an art dealer and as a missionary, before turning to painting as a way of serving mankind. His life was unhappy and disturbed, and he relied greatly on the support of his brother Theo.

Van Gogh's early works were mostly about the lives of poor and downtrodden people, and were painted in dark, sad colours. His later love of vivid colours was inspired by seeing some of Rubens' paintings, and he was greatly influenced by his contacts with Cézanne, Gauguin and other artists who were using new, exciting techniques. In 1888, he went to Arles in southern France. He worked feverishly, but recurring fits of insanity tormented him. In July, 1890, he committed suicide.

Gold is one of our most precious metals. Its beautiful 'golden' colour never dulls. It never corrodes. And it can be shaped more easily than any other metal. These properties have made gold the most sought-after metal for thousands of years. Gold was one of the earliest metals known because it is found in the pure state in the ground.

The main use of gold today is as a monetary standard. (See Money.) But the most familiar use is for ornaments and



The discovery of gold in the Klondike river in Alaska and Canada in 1896 led to a gold rush. Even today, prospectors still pan for gold along the river.

Pure gold is too soft for day-to-day jewellery like wedding rings. A little copper or silver is added to make it harder.

The amount of gold in the alloy is indicated in terms of carats, or twenty-fourth parts: 24-carat gold is pure; 22-carat gold has two twenty-fourths of alloying elements; and so on.

Gold was once widely used for coins, but few are minted today.

Talking points

*Since the beginning of civilization, gold has been looked upon as being valuable. Also, it has been the basis of money systems until the present century. Discuss why gold has held this unique position.

*Gold has a combination of qualities that no other metal has. Make a list of them and discuss how Man has made use of them.

*One of the main uses of gold is in making jewellery, but pure gold is hardly ever used for this. Why do you think that this is so?

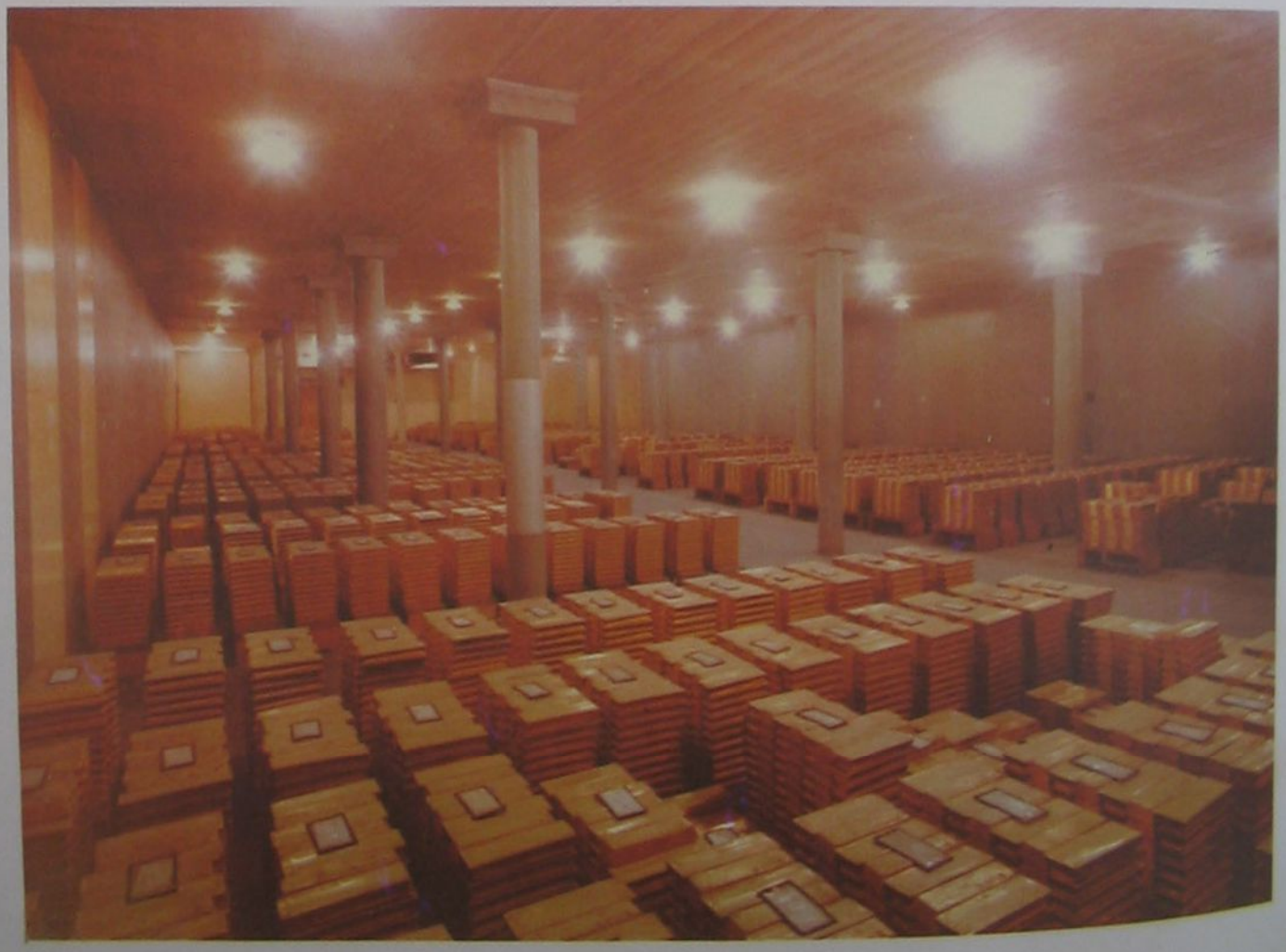
Articles to read

Jewellery; Mining; Money.

jewellery. Gold can be made into delicate webs, drawn into fine wire, and beaten into almost transparent leaf.

Gold Rush In the middle and late 1800's the discovery of gold in many newly settled parts of Canada, the United

A gold vault in the Bank of England. Each bar is worth about £6,000.



States, Australia and New Zealand caused thousands of people to flock to these areas in the hope of making their fortunes. The places where these 'gold rushes' occurred included the Klondike region of Canada, California in the United States, Otago in New Zealand and Queensland and Western Australia. The fortune hunters were known as *prospectors*.

The gold rushes turned small outposts into thriving towns overnight. Those who didn't intend to get rich on gold often got richer selling food, liquor, shelter and equipment to the prospectors at highly inflated prices. The atmosphere of the 'boom towns' was often lawless and tough because they had no effective governments.

A prospector usually carried a pick, shovel and bucket. He searched for the glittering specks of gold in the bed of a river, and swirled the river mud around in a pan to separate the heavier gold from the lighter earth and rock. If he was lucky he went back to town with nuggets of gold or gold dust to sell. The prospectors lived rough in harsh conditions, sometimes cold and wet, sometimes short of water under a burning sun.

Although some settlements died once the rush was over, many survived as permanent towns. The gold rushes served to extend frontiers to undeveloped regions.

Golf The object of this popular game of Scottish or Dutch origin is to hit a stationary ball into standard-sized holes (4¾ ins. diameter and at least 4 ins. deep) usually 18 in number, placed in order at varying distances apart round a grassland course.

Any number of players may take part, each being allowed a set of steel-shafted clubs, to a maximum of 14, from which one most useful for each shot is selected.

Each hole is reached by playing the ball from a starting 'tee', along a 'fairway', to the 'green', the length of a hole varying from 100-500 yards. Hazards such as bunkers and traps, ditches, trees and rough grass are laid at vulnerable points.

The equipment used in the game of golf. When 'driving off' the balls are placed on the wooden or plastic tees. The clubs are a putter, a wooden driver and an iron.

Clubs with wooden heads are used for powerful drives. Others have steel heads variously shaped to suit all other plays. The 'putter' is reserved for play on the green, the small smooth area surrounding the hole.

The ball is composed of elastic thread wound round a soft core with an outer cover of vulcanised rubber. Its weight must not exceed 1.62 oz. The minimum diameter is 1.61 ins., but the ball normally used in the U.S.A. has a 1.68 ins. diameter.

There are two main types of competition. In 'medal play' the winner is the one who takes the least number of strokes overall; in 'match-play' the result depends on the number of holes won from an opponent. A system of handicapping is

A player drives off from the fifth tee on the Royal Golf Course, Melbourne, Australia. This is one of the finest golf links south of the Equator. The World Cup championship was held here in 1972.

employed to match unequal opponents. This is an allowance of strokes made to the average golfer; the lower the handicap, the better the player.

The Royal and Ancient Club at St. Andrews was founded in 1754, but the Gentleman Golfers of Edinburgh was formed 10 years earlier. The oldest existing club in North America is the Royal Montreal, formed 1873.

Gourd is the name given to a group of trailing ornamental plants. They are distinguished by their usually large fruits of various colours and shapes. Gourds grow wild in parts of India, America, Africa and some Pacific Islands. Many of the fruits can be eaten, but others are grown merely for decoration. Members of the family include squashes, melons, pumpkins and cucumbers.

Government People do not live on their own. They live with other people in a community. The nation state is a community; that is a group of people living in one country, usually speaking the same language, having a common way of life and a common government. When millions of people live and work together it has to be made very clear who gives the orders. Giving orders in a nation is ruling; the government of each nation rules it. Without a government there would be no police force, no postal service, no doctors and hospitals, no electricity, gas nor coal.

Every nation has a Head of State; the Queen is the British Head of State. She represents the nation in its relations with other states. Ambassadors from foreign countries call on the Queen to announce their arrival. Treaties with foreign countries are made in the Queen's name. Every law the government makes has to be signed by the Queen before it can be put into force. The Queen is the permanent representative of the State.

Most countries do not have a King or Queen as Head of State; they have a President. Such countries are called Republics. A President is chosen from the citizens of a country because his fellow citizens believe that he will make the best representative. He is usually a well-known public figure. In most countries the President holds office for only a limited period; a new President is then chosen. This is to prevent any one man becoming too important.

The Queen does not govern the country; nor do many Presidents. The government rules in the Queen's name, but the real head of the government is the Prime

(first) Minister. The Prime Minister governs with the help of a selected number of senior Ministers; this is the Cabinet. The Prime Minister chooses his Cabinet and presides over Cabinet meetings, which decide overall policy. The government's work is carried out by a number of different Ministers. The Queen invites the man who has the support of the majority of the members of parliament to become Prime Minister.

In the United States of America the roles of Head of State and Prime Minister are combined. The American President commands the armed forces and fixes the budget of the richest nation in the world. The President is elected every four years. He has a Cabinet, but neither the President nor his Cabinet Ministers are members of the U.S. parliament. This means that the President has even more influence over his Cabinet than the British Prime Minister. But the American President may find his government opposed by Congress; a British Prime Minister always has a parliamentary majority.

Many nations have Presidents who really rule. The French President has a Prime Minister, but it is the President who decides policy. So do the Presidents of Pakistan, Egypt and Yugoslavia. But in India, Germany and Ireland the President is only the Head of State, and a Prime Minister is the head of the government. (See Parliament; Political Parties.)

Talking points

*Since the French Revolution in 1789, monarchy has played less and less of a part in government. In most countries now, the government is in the hands of an elected parliament. Why has the monarchy lost its power?

*Some countries of the world have *totalitarian* governments. They are ruled by dictators or by a military junta who allow no democratic opposition. How important do you think political freedom is?

*Some people complain that there is 'too much government'. Do you think that governments interfere too much into the lives of ordinary people?

Articles to read

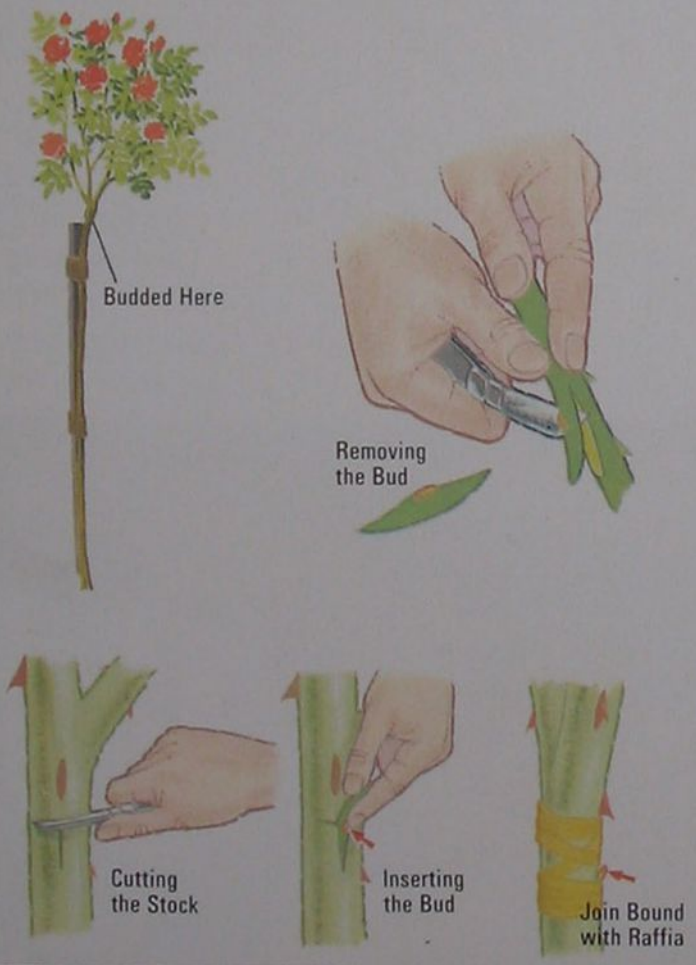
Communism; Democracy; Elections; Parliament.

Grafting is a method of plant breeding in which a cutting from one plant is bound on to the stem of another plant. If the graft 'takes', the two parts grow together as one plant. This method is used by nurserymen to produce their supplies of fruit trees. Cuttings from the various

The mace on the table in the Canadian House of Parliament represents the authority of the Queen, who is the head of state. The mace has been a symbol of authority since the Middle Ages. It developed from the iron club that archers used to fight with. Note that the date on the table is written in both English and French.

varieties of apple, for example, are grafted on to the stems of young wild apples. As long as all the later branches come from above the graft, the fruit will be of the appropriate variety. Many varieties of fruit do not grow well on their own, or they may suffer from various diseases. Grafting these varieties on to stronger varieties often overcomes these disadvantages. Only fairly closely related plants can be grafted with success. An apple could not be grafted on to an oak.

Budding Standard Roses. The bud is inserted at the height required for the head of flowers. Budding is a form of grafting in which a single bud is taken and joined on to another plant. It is used especially with roses.



Grammar is the set of rules that governs a language. Each language has its own set of rules. These rules decide the way in which words should be arranged, and in many languages they also govern word spellings.

The sentence is the basic unit of grammar. A sentence is a complete statement or thought, for example, 'Jill ate her hot pudding slowly'. A sentence must have a *subject* and a *verb*. The subject ('Jill', in our example) is who or what the sentence is about. The verb is the action word ('ate'). The subject is always a *noun* (a word meaning a person, place or thing, such as 'Henry', 'London' or 'table') or a *pronoun* (a word like 'they', or 'it', which stands for a noun). The *object* of a sentence tells who or what the action is done to ('Pudding'). It, too, is a noun or pronoun.

Words that *modify* (describe) nouns are called *adjectives* ('hot'). Adverbs are words that modify verbs. For example, 'slowly' tells how Jill ate her pudding. 'And', 'but' or 'or' are examples of *conjunctions*. They join words or phrases. 'To', 'in' and 'on' are examples of *prepositions*—for instance 'Jill ate her hot pudding slowly and went to the park.' Words such as 'has' in 'she has eaten' are known as *function words*. They tell us more about the verb—in this case, that the event is past.

Languages differ from each other in many ways. One big difference between languages is the number of *inflexions* they have. Inflexions are changes in a word's structure. For example, they show whether it is singular or plural. In many languages they show whether it is masculine or feminine or even neuter. In German pencil is masculine—der Bleistift; pen is feminine—die Feder; and paper is neuter das Papier.

In some languages such as German inflexions show whether a word is the subject or object. English has few inflexions, except for plurals (hand—hands).

Grand Canyon is one of the greatest natural wonders of the world. It is a deep valley in north-western Arizona, in the south-western United States. The Colorado River flows through it. The canyon is more than a mile deep in places and extends about 200 miles.

The top of the canyon lies between 5,000 and 9,000 feet above sea-level. From rim to rim, the canyon is between 2 and 18 miles wide. Within the canyon are

The Grand Canyon is the result of the Colorado River cutting deeper and deeper into the sand and gravel of a high plateau in Arizona. The Canyon is now about 200 miles long, up to a mile deep, and 2 to 18 miles across. It is one of the most amazing sights in the world.

smaller cliffs, jagged pinnacles of rock and steep-sided tributary valleys.

A 105-mile stretch of the Grand Canyon now forms a national park. Every year, many tourists visit the area. Some people explore the canyon on horseback. From the top of the canyon, others photograph the beautifully coloured rocks in the canyon. The colours include reds, greys, creams and sandy-browns.

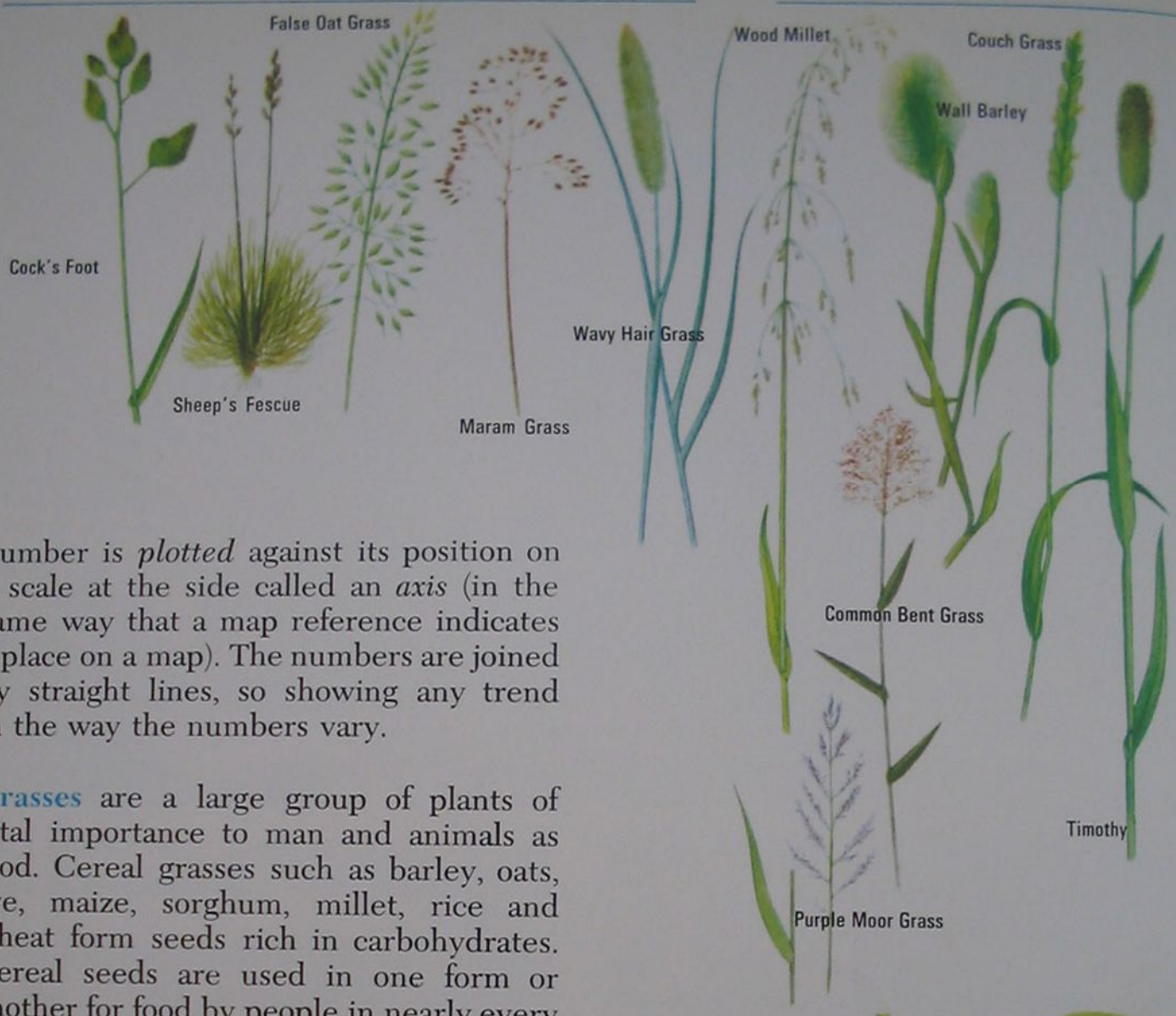
The swift-flowing Colorado River runs through a gorge at the bottom of the canyon. This great river and its tributaries have worn out this deep valley. The Colorado River is still shifting millions of tons of sand and gravel each year. This gradual process is called *river erosion.* Scientists estimate that the river has eroded about 1,000 cubic miles of rock from the canyon in the past million years.

Pueblo Indians were once the only inhabitants of the region. Spaniards discovered the Grand Canyon in 1540. In 1869, the American geologist John Wesley Powell was the first to navigate the dangerous Colorado River. The Grand Canyon area was made a national park in 1919.

Graphs are a way of showing mathematical quantities on diagrams. Figures can be easier to understand and compare when they are drawn on a graph. There are various kinds of graphs, and a mathematician chooses the type that best shows how the figures relate to each other. For instance, if he wants to show how a country allocates money in its budget he may use a *pie chart.* This consists of a circle graph cut up into segments, like slices of a pie. The size of each slice represents a certain fraction of the whole budget.

In a *bar graph,* or *histogram,* bars or columns represent numbers. The length of the bar or height of the column is proportional to the number. This type of graph is often used to compare numbers that change regularly, such as the rainfall every month.

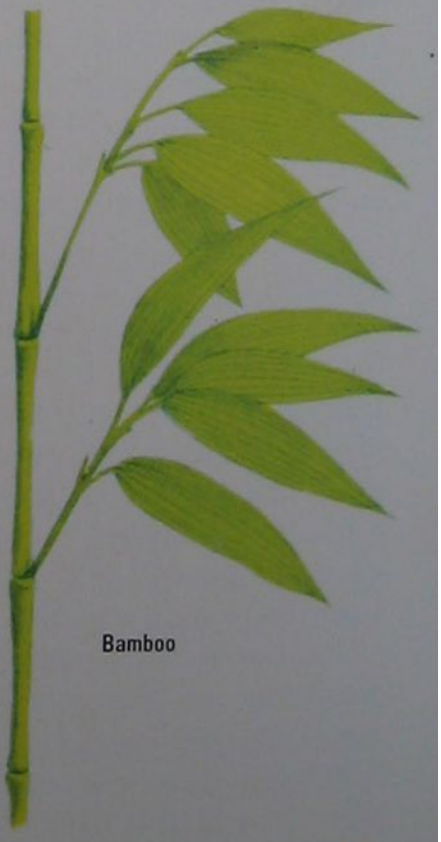
A *line graph* is the commonest kind. A



number is *plotted* against its position on a scale at the side called an *axis* (in the same way that a map reference indicates a place on a map). The numbers are joined by straight lines, so showing any trend in the way the numbers vary.

Grasses are a large group of plants of vital importance to man and animals as food. Cereal grasses such as barley, oats, rye, maize, sorghum, millet, rice and wheat form seeds rich in carbohydrates. Cereal seeds are used in one form or another for food by people in nearly every part of the world. Forage grasses are eaten by grazing animals, either fresh in the fields in summer, or dried as hay or preserved as silage in winter. Sugar cane is of vast importance as a commercial crop in many tropical areas.

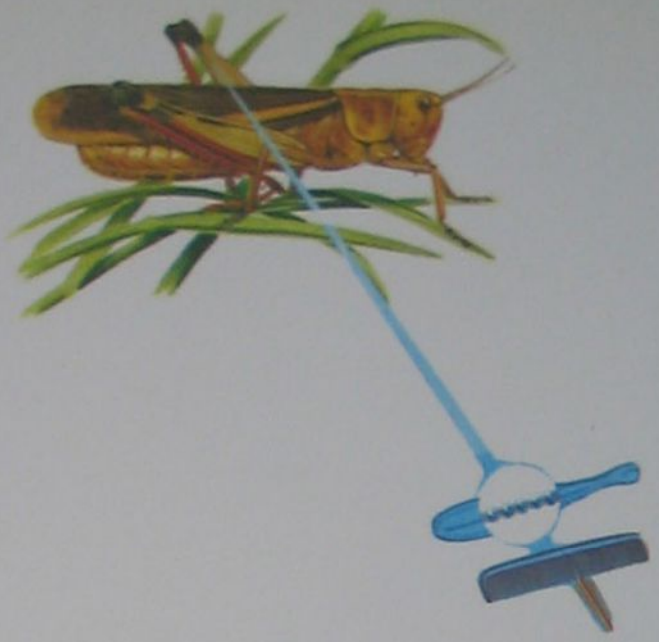
Most grasses are small plants and grow no more than two feet high. They are almost all *herbaceous*—that is, their stems are not woody. Bamboos and sugar cane are exceptions. Some bamboos grow up to 100 feet high, and are widely used for building and many other purposes in the tropical regions where they flourish. Grass stems are hollow except where leaves come off the stem. At that point, a slightly swollen, solid plug of tissue occurs, called a *node*. Grass leaves are long, thin, and pointed and have parallel veins. Their roots are fibrous and com-



SOME COMMON GRASSES

Right: The short-horned grasshopper makes its chirping sound by rubbing its hind legs across the ridges in its wings. The inset shows the little pegs on the grasshopper's leg. The pegs strike the wing veins and set up vibrations in the same way that a comb vibrates when rubbed against a hard edge.

Below: A bush cricket – one of the long-horned grasshoppers that chirps by rubbing the base of the front wings together.



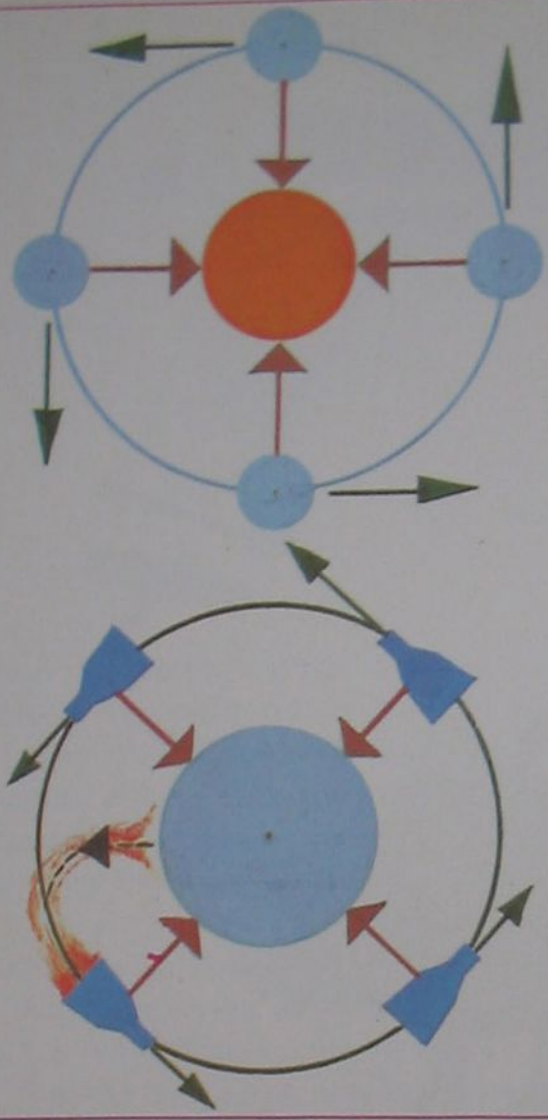
monly form a dense, shallow *sward*, binding the soil together. For this reason, grasses are often valuable as stabilizers of soil, preventing it from blowing away in the wind. Grass flowers arise in *spikelets* containing one to five flowers. They are not at all like ordinary flowers – they have no coloured petals. Stamens and ovary are usually enclosed in a pair of drab-green covers called *glumes*. Grass flowers are pollinated by wind.

Grasses are unusual plants in that their leaves grow from the base. As a result, grasses can keep growing despite being grazed or mown periodically. Grazing and mowing actually encourages most grasses to develop numerous side-shoots and leads to the development of a thicker growth. Many grasses can spread rapidly by means of stems that grow horizontally underground. One of these grasses, couch grass, is a notoriously troublesome weed.

Grasshoppers and crickets are jumping insects heard 'chirping' but not often seen. There are three kinds of grasshoppers and crickets. *Short-horned* grasshoppers have short feelers on their heads. They chirp by rubbing the inside of their back legs on a hard ridge on

their wing covers. These are the true grasshoppers of the meadows. Locusts are also short-horned grasshoppers (see Locust). *Long-horned* grasshoppers have long feelers and chirp by rubbing their wing covers together. They are usually found in hedges and bushes and are more correctly called bush crickets. *Crickets* resemble long-horned grasshoppers, except that they are flatter and have two 'feelers' protruding from the tail end.

Only male crickets and grasshoppers chirp. The females are silent. They lay their eggs by drilling a hole in the soil and leaving the eggs in the hole all winter to hatch the following spring. This is done with an organ at the end of the body called an *ovipositor*. In long-horned grasshoppers and crickets, the ovipositor is long and sword-like. In short-horned grasshoppers it is much smaller. Most of these insects have good wings, but few of them fly very often. Grasshoppers have powerful hind legs and are able to jump up to 20 times the length of their bodies.



Above: The top diagram shows the Earth circling the Sun, held in its orbit by gravitational attraction. The lower diagram shows how a satellite circles the Earth in exactly the same manner.

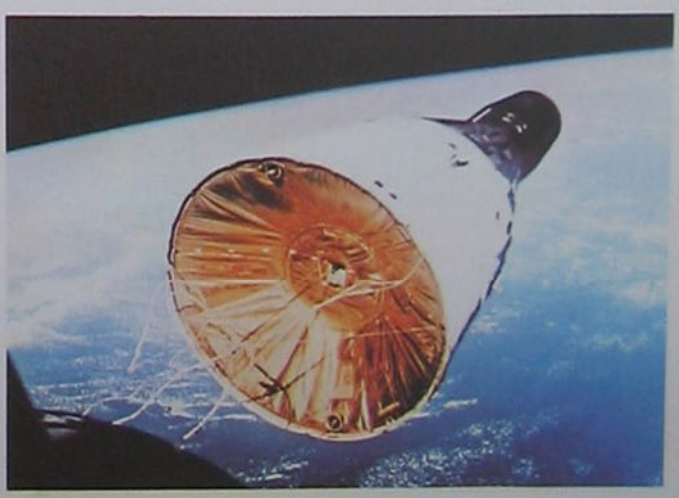
Left: Hot air balloons appear to overcome the force of gravity because warm air is lighter than cold air.

Below: Specks of matter in space would eventually be drawn together by their mutual gravitational attraction.

Gravitation is a force of attraction that all objects in the Universe exert on each other. The Earth has such a strong gravitational field, or force of gravity, that it keeps all of us and everything on the Earth to the ground. If we lift up a weight and let go, the force of gravity acts on it to pull it down to the ground: the object falls. All objects possess gravitation. A raised weight attracts the Earth at the same time as the Earth attracts the weight. But it is such a weak force that only the gravity of very large objects, such as the Earth, Moon and Sun, is powerful enough to affect us.

The Earth, Moon and Sun influence each other. The tides are caused by the gravitational fields of the Sun and Moon acting on the water in the oceans and pulling it slightly to one side of the Earth (see Tides). The Earth's force of gravity attracts the Moon and man-made satellites towards the Earth. But as they move around the Earth, their movement out-

The terrific thrust of a modern space rocket (left) enables it to overcome the Earth's gravitational force and place a space capsule in free orbit (below). The capsule circles the Earth because its tendency to fly away into space is balanced by the gravitational attraction of the planet. When an astronaut leaves a space capsule and 'walks' in space hundreds of miles above the Earth he is travelling at the same speed and subject to the same gravitational attraction as the capsule. In order to return to Earth, the astronauts fire retro-rockets which reduce the speed of the space capsule. The gravitational attraction of the Earth is then able to draw the capsule back to the ground.



wards is balanced exactly by the Earth's force of gravity. As a result, they remain orbiting at a constant distance from the Earth. In the same way, the Earth and other planets orbit the Sun.

The strength of a planet's field of gravity depends on its size and mass. The force of gravity on the Moon, for example, is a sixth of that on the Earth. This means that a man will have a sixth of his Earth weight when standing on the Moon, and he will be able to jump higher above the surface. Apart from record high jumps, a man's low weight will mean that there is less friction between his feet and the ground, and he will tend to slip.

The attraction of gravity between two objects weakens the farther apart they are. When a rocket is fired away from the Earth, it starts to slow down when the engine stops, as the attraction of the Earth's gravity tries to pull it back. Although the pull gets weaker the farther away the rocket goes, if it leaves at a speed of less than 25,000 miles an hour, it will eventually slow to a stop.

Great Barrier Reef is a chain of islands and coral reefs stretching for 1,200 miles along the coast of Queensland in north-east Australia. It is the largest such formation in the world. Some of the islands of the reef are only 10 miles from the Queensland coast, but others are up to 160 miles distant.

Some of the islands of the Reef are part of the continent itself. These are the tops of a now-sunken mountain range, and have rocky cliffs. The other islands are true coral islands, built up over millions of years from the skeletons of animals called *coral polyps*. The corals are found in all sorts of unusual shapes and a variety of lovely colours. Giant sea turtles and other strange marine animals inhabit the reef.

Swimming, sailing, water-skiing and skin-diving attract many tourists to the region. There are resorts on several of the larger islands, chiefly those of the Whitsunday group, in the south.

In 1963 it was discovered that large numbers of Crown of Thorns Starfish had descended on the Great Barrier Reef and were eating the living coral polyps. They have done so much damage that portions of the Reef are threatened with complete destruction. When the polyps have been eaten by the starfish, the dead coral skeletons that make up the reef become eroded by the waves or covered in seaweed. As a result of this, many of the fishes and other creatures that inhabit the reef either die or move to other areas.

An aerial view of Heron Island, one of the many beautiful coral islands that make up the Great Barrier Reef. Heron Island is a popular holiday resort.

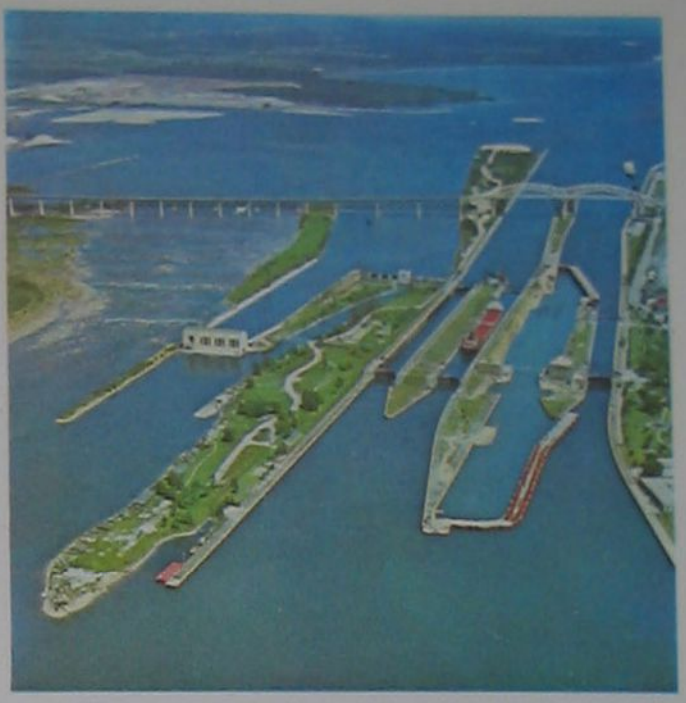
Great Bear Lake, Canada's biggest freshwater Lake, covers 12,275 square miles in the Northwest Territories. The Great Bear River carries water from the lake into the Mackenzie River. It is frozen for about nine months of the year. Bears inhabit the woods around, and salmon and other fish live in the lake waters. Fur traders established the first settlement on the lake in the early 1800's. Today, there are uranium and silver mines, and oil refineries.

Great Britain. See England; Scotland; United Kingdom; Wales.

Great Dividing Range is a vast mountain system in Australia that runs for 1,500 miles parallel to the east and south-east coasts. In the south, it extends to Tasmania. Parts of it are also called the Eastern Highlands.

The range is made up of several mountain groups that vary from about 2,000 to 7,000 feet in height. They include the Drummond Range, the New England Range, the Blue Mountains, the Cullarin Range and the Australian Alps. Mt. Kosciusko (7,316 ft.) in New South Wales is Australia's highest point. It is a peak of the Australian Alps.

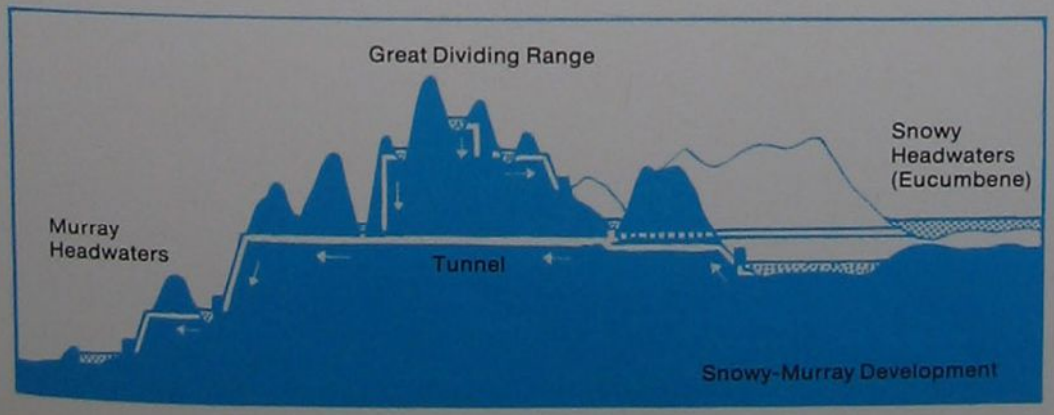
From their sources in the Great Dividing Range some rivers flow east to the Pacific Ocean: others empty into the Gulf of Carpentaria in the north or into the Indian Ocean in the south. Many parts of the Range have warm, moist climates, and fertile lands for grazing and agriculture.



An endless procession of merchant ships pass through the locks and ship canals of the Great Lakes. A bigger tonnage of shipping goes through them every year than goes through the Panama and Kiel Canals combined. Grain and iron ore from Minnesota, timber from Ontario and coal from Pennsylvania are among the many important cargoes transported via the Great Lakes.

Great Lakes The Great Lakes of North America are the world's largest group of lakes. They cover a combined area of about 94,700 square miles. The Great Lakes are an extremely important waterway. Ships transport large quantities of such raw materials and foodstuffs as coal, iron ore, timber and wheat.

Of the five Great Lakes, four of them form part of the Canada-United States border. Lake Michigan lies entirely in the United States. The largest and deepest is Lake Superior. Lake Ontario is the smallest. The magnificent Niagara Falls



Left: A diagram of part of the Snowy Mountains scheme, one of the boldest irrigation and power projects of modern times. The abundant waters of the Snowy River are being impounded and led back through the mountains for electric power generation and to augment the Murray and Murrumbidgee rivers for inland irrigation.

The Great Lakes are the largest system of inland water in the world. They carry a large amount of shipping and are linked to the Atlantic by the St. Lawrence Seaway.

lies between Lake Ontario and Lake Erie. A river which flows past the city of Detroit in the United States connects Lake Erie to Lake Huron.

Lake Ontario is linked to the Atlantic Ocean by the great system of canals and locks called the St. Lawrence Seaway. This 182-mile-long seaway from Montreal to Lake Ontario was officially opened in June, 1959. Other canals connect the various lakes and provide alternative routes to the sea through the United States. Ships avoid the obstacle of the Niagara Falls by sailing through the Welland Ship Canal between Lake Ontario and Lake Erie.

Sailing on the lakes can be rough in windy weather and sturdy boats must be used. Special barge-like vessels that lie low in the water carry large cargoes. Parts of the lakes freeze over during the winter. But ice-breakers keep the main shipping routes open. The important Canadian city of Toronto lies on the shores of Lake Ontario. United States cities on the Great Lakes include Buffalo, Chicago, Cleveland and Milwaukee. About 40 miles north of Chicago lies the United States Navy's largest training centre, where more than a million sailors have been trained.

Many resorts lie around the shores of the Great Lakes. The most popular resort is Niagara Falls, where water from Lake Erie cascades nearly 200 feet down to Lake Ontario.

Great Slave Lake, in the Northwest Territories of Canada, takes its name from the Slave Indians who inhabited the region. It is one of the largest in America and has an area of 11,170 square miles. It freezes part of the year. The Slave River is the largest river feeding the lake. From the lake, water flows into the Mackenzie River. *Tundra* (subarctic plains) and forest surround it. Fish are caught commercially, and gold and lead-zinc ore are mined nearby.

Great Wall of China The 'Long Wall of Ten Thousand Miles', which we call the Great Wall, was built between 230 and 220 B.C. It is about 1,600 miles long and stretches from a pillar by the sea, 'the Pillar-Bridge of Heaven', into the western mountains. It runs along the northern edge of the Yellow river plain.

The Great Wall of China is between 15 and 39 feet high and is up to 32 feet thick. It is the greatest construction ever made by Man. It was kept in repair until the 1500's.

The Great Wall of China winds its way over the mountains in the north of the country.
It is strengthened with forts and watchtowers and was built to keep out barbarian nomads.

The wall was built, with watchtowers and forts, to protect China from the 'Western barbarians', the Hsiung Nu, known to Europeans as the Huns.

Between 260 and 221 B.C. the Chin emperors united the huge area around the Yellow and the Yangtze rivers. This was called China after them. To the west, as far as central Europe, there stretched open grass steppes. The tribes who lived there were nomads. They were wanderers. On many occasions through history they united in attacks on the civilized areas which surrounded them. The Chin emperor sent 300,000 soldiers, criminals, unreliable civil servants and disloyal writers to build the Great Wall against these nomads.

Greece is a country in the Balkans, in south-eastern Europe. It consists of a long and irregular peninsula, and many islands of which Crete, Lesbos and Rhodes are the largest. Many people visit Greece to enjoy its warm, sunny climate and to see the impressive ruins of Greece's ancient civilization (see Greece, Ancient).

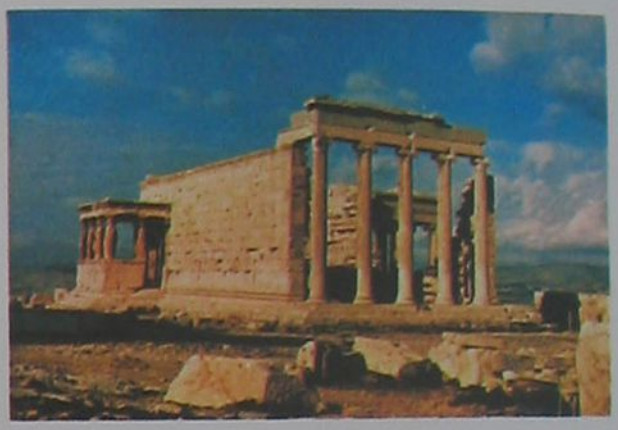
Albania borders Greece to the north-west, Yugoslavia and Bulgaria to the north, and Turkey to the north-east. Greece has a long, ragged coastline. On the west lies the Ionian Sea, on the east is the Aegean Sea, and to the south is the Mediterranean Sea.

Northern Greece is the widest part from east to west. Macedonia, the north-eastern part, has coastal plains where the people grow wheat and other cereals, and vines. The three-pronged peninsula of Chalkidike, south of the Macedonian plain, is mountainous. On the slopes of lofty Mount Athos stands a group of 20 monasteries.

North-western Greece is covered by the high, thickly forested, Pindus Mountains. The Plain of Thessaly, to the east of the mountains, is closely covered with vineyards.

South of the Pindus Mountains is high plateau land, in which some of the mountain slopes are forested, while others are dry and barren. In the south-eastern part of this area stands the city of Athens, the capital of Greece. It has a busy port at Piraeus and many factories.

Southern Greece, the Peloponnese Peninsula, is almost an island. It is joined to the mainland by the *isthmus* (a narrow strip of land) of Corinth. A canal has been driven through the high rock of the isthmus. The peninsula has mountains rising to over 6,000 feet above sea level. Some of its slopes are forested and some barren. Farmers grow vines, olives, and oranges, and rear goats in the area.



Above: The ruins of Erechtheum on the Acropolis (citadel) in Athens, the capital of Greece. The temple was dedicated to Athena, the goddess of wisdom.

The people of Greece are mostly Christians, belonging to the Eastern Orthodox Church. Most of them work on the land. Greece has few industries. Its natural resources include lignite (poor quality brown coal), iron ore and bauxite. It has a large merchant navy.

After the fall of the Greek and Roman Empires, Greece formed part of the Byzantine Empire, the eastern part of the old Roman Empire. Greece was conquered by the Turks in the mid-1400's. The Greeks rebelled, declared independence in 1822, and won final freedom in 1830. Greece became a monarchy.

In 1912 and 1913, Greece fought Turkey and other Balkan countries in two wars. It also fought in World War I. In World War II, Greece defeated the Italians but fell to the Germans.

Greece had an elected parliament. But

in 1967, a group of army leaders seized power. The king, Constantine II, failed to overthrow them, and fled into exile.

Facts and Figures
Area: 50,944 square miles.
Population: 8,736,000.
Capital: Athens.

Greece, Ancient Greece was invaded and settled by waves of people, including Minoans, Achaeans, Dorians. They intermarried and developed the Greek language. By 1500 B.C. there were flourishing cities inhabited by Greek-speaking people on the mainland of Asia Minor and round the shores of the Black Sea, as well as in Greece.

Greece is a mountainous country with a long, indented coastline and communication between one valley and another is difficult. Consequently, separate *city-states* grew up.

Owing to the scarcity of fertile land in this mountainous country many took to the sea as fishermen and traders. They began to settle overseas, as far away as Sicily and Marseilles. The cities they founded traded with their parent city, sending wheat to Greece and importing olives, one of Greece's main products.

The practice of politics was the outstanding Greek gift to the world. The Greek word for a city-state is 'polis' and the word 'politics' comes from this. The city-states tried every type of government, including monarchy, aristocracy and tyranny, but the most widely practised was democracy. In Athens, for example, every male citizen had a voice and a vote in running the city. The city was so small that everyone could meet and discuss public affairs. But women, slaves and foreigners had no part in government. Sparta was quite different. It was organized for war; the Spartans feared the *helots*, the original inhabitants who had become slaves. Girls as well as boys were trained for a hard life without comfort or the pleasures of art and literature. Sparta

Greece is poor in natural resources. Almost two-thirds of its entire area is barren rock.

Above: A typical scene in Corfu, Northern Greece where the land is comparatively lush and fertile.

Left: Location map of Greece.

Below: A rocky mountain area, characteristic of many parts, where it is hard for farmers to win a living from the land.

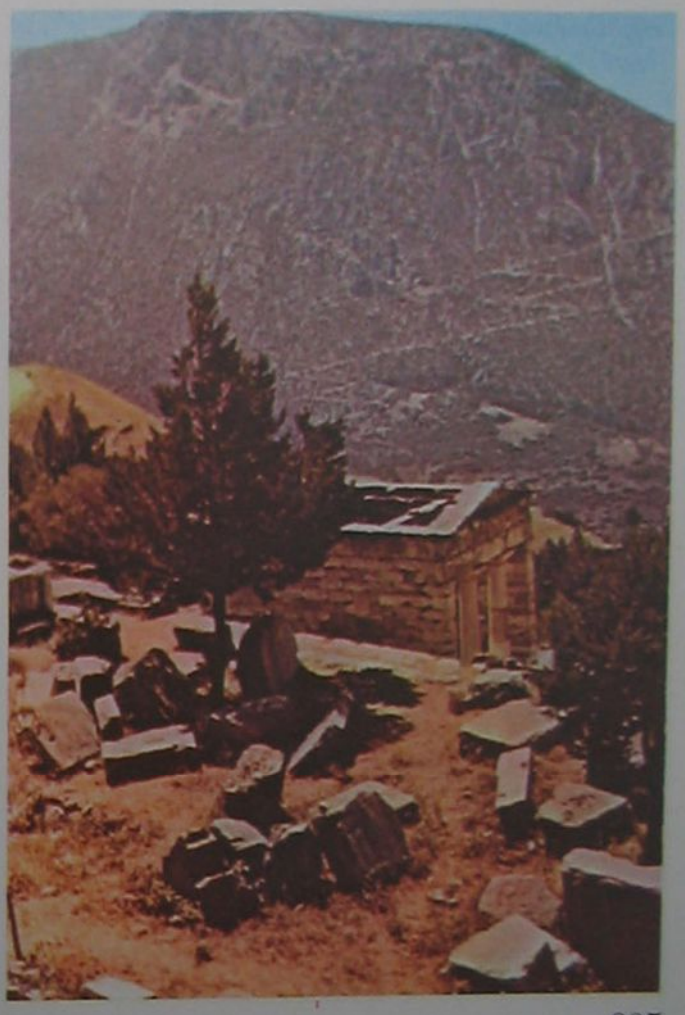


Photo: Sonia Halliday

The entrance to the Royal Grave Circle among the ruins of the ancient Greek city of Mycenae. The city flourished from about 1450 B.C. to about 1100 B.C., when it was the centre of the Bronze Age culture in Greece.

alone among Greek states had no beautiful buildings or works of art.

In the fifth century B.C. some of the Greek cities of Asia Minor revolted against the huge Persian empire. Athens helped them and was consequently attacked by the Persians.

The little Athenian army, astonishingly, defeated the Persians at the battle of Marathon (490 B.C.). There was peace for ten years. Then Xerxes, the Persian king, invaded Greece. At the pass of Thermopylae a handful of Spartans held up the Persian advance while Athens was evacuated. The Athenian fleet skilfully defeated the Persian navy in a great sea battle at Salamis.

Gravestones in Ancient Greece (see left) were carved in relief with portraits of the people commemorated, often showing them in some familiar scene from their lifetime. Stones such as these, and other findings, have yielded valuable information for archaeologists looking into the past.

After the defeat of Persia there was a marvellous flowering of Greek culture, above all in Athens. The Parthenon, a perfectly proportioned temple, was built on the Acropolis between 447 and 432 B.C. Sculptors like Phidias (c. 490-432) and dramatists like Aeschylus (525-456) and Sophocles (495-406) delighted the Athenians with their works. Philosophy, the study of truth and clear thinking, reached a peak with the teaching of Socrates (469-399) and his pupil Plato (428-347). Herodotus (484-?) and Thucydides (471-c.402) wrote the first real histories.

Athens built up an empire, the Con-

Greece has been called 'the Birthplace of Civilization'. Its literature, sculpture, architecture, philosophy and politics have had more influence on European culture than those of any other ancient civilization. The Greek language also has influenced modern European languages and many English words are derived from it.

federacy of Delos, whose members had to pay for a common fleet, but in doing so she made enemies. In 431 B.C. Sparta joined the Athenians' enemies and the long Peloponnesian war began. Under the outstanding statesman Pericles, Athens was at first successful, but she was ultimately defeated in 404 and had to admit a Spartan garrison.

The Greek city states never learned to live together in peace. The Olympic Games which took place every four years and the Oracle at Delphi were the only things which all Greeks shared and respected. Wars continued until Philip, king of Macedon, defeated Thebes and Athens and united Greece in 338 B.C. Macedonia was a mountainous state to the north.

Philip planned to conquer the Persian empire, but he was assassinated. His son Alexander carried out the plan. Alexander was educated by Plato's pupil, the philosopher, Aristotle (384-322). In thirteen years Alexander the Great conquered Asia Minor, Syria, Egypt and Persia. He even reached the river Indus. Alexander founded seventy new Greek cities, from which Greek ideas and art spread throughout the Middle East. Alexandria in Egypt is the most famous of these cities. Alexander died in 323 B.C.

Greek myths are stories of the gods and goddesses worshipped by the ancient Greeks before the beginning of the Christian era. The authors of these tales are unknown, but we do know that the stories were passed on from generation to generation. Eventually, they were written down by Greek and Roman poets. Characters and situations from the myths have appeared in literature over the centuries, and although no one today worships the old Greek gods, modern authors still write novels and plays based on these ancient stories.

The Ancient Greeks were skilled and hardy sailors. In ships like the one pictured below they explored the Mediterranean Sea and spread their knowledge and culture to all parts of the Ancient world. The voyages of Ulysses are the subject of Homer's *Odyssey*, one of the greatest epic poems of Ancient Greece.

Famous Names of Greek Mythology

Acheron: River in the Underworld.
Achilles: Greek hero in Trojan War; killed by Paris with an arrow in the heel, his only mortal spot.
Actaeon: Hunter; punished by Artemis; transformed into a stag and killed by his own hounds.
Adonis: Beautiful youth loved by Aphrodite.
Aeneas: Trojan prince; his wanderings after the fall of Troy form the tales of Virgil's *Aeneid*.
Aesculapius: God of healing.
Agamemnon: Commander of Greek armies in Trojan War; killed by wife Clytemnestra as prophesied by Cassandra.
Ajax: Great friend and fellow-warrior of Achilles.
Amazons: Mythical race of war-like women.
Andromache: Wife of Hector, Trojan prince.
Andromeda: Angered Poseidon; was chained to a rock to be eaten by sea-monster but rescued by Perseus.
Aphrodite (Venus): Goddess of love and beauty.
Apollo: Son of Zeus, chariot-driver of the Sun; also god of music, the arts, medicine, and prophecy.
Ares (Mars): God of war, son of Zeus, lover of Aphrodite.
Argonauts: Greek heroes, companions of Jason, sailed in the *Argo* in search of the Golden Fleece.
Argos: King of Argos, who had a hundred eyes of which only fifty slept at once.
Ariadne: Daughter of Minos, king of Crete; helped Theseus escape from the Minotaur's labyrinth with thread.
Artemis (Diana): Twin sister of Apollo; goddess of the hunt, of the moon (Selene), and of magic (Hecate).
Atalanta: Would only marry the man who could beat her in a running race. Hippomenes succeeded with help of Aphrodite and golden apples from Garden of Hesperides.
Atlas: Refused to shelter Perseus; was turned into Atlas Mountain and condemned to support the heavens.
Bellerophon: Aided by Pallas Athene and riding Pegasus, slew the Chimaera.
Calypso: Nymph on island of Ogygia; kept Odysseus prisoner for seven years.
Cassandra: Prophetess-maiden, daughter of Priam, taken as booty by Agamemnon.
Centaurs: Half man, half horse; lived on Mount Pelion.
Cerberus: Many-headed dog; guarded gateway to Underworld.
Charities (Graces): Three attendants of Aphrodite.
Charon: Ferried souls of dead over rivers of Hades.
Chimaera: Monster with lion's head, goat's body, dragon's tail.
Chiron: A Centaur, tutor of the gods.
Cronos (Saturn): Oldest of gods; devoured sons at birth so as to retain his throne; usurped by Zeus.
Cyclops: Giant with one eye in middle of forehead.
Daedalus: Craftsman, flew with wings made out of wax.
Demeter (Ceres): Goddess of produce of the earth.
Dionysus (Bacchus): God of wine, mirth and revelry.
Electra: Daughter of Agamemnon; Orestes' sister.
Endymion: Beautiful youth beloved by Selene, who put him in a perpetual sleep.
Eos: Daughter of Hyperion, goddess of the dawn.
Eris: Goddess of discord.
Eros (Cupid): God of love.
Eumenides (Furies): Winged maidens, avenging deities.
Europa: Beautiful nymph, carried by Zeus in guise of a bull across the sea to Crete.
Fates: Three sisters who controlled the destiny of men.
Ganymede: Mortal prince; became Zeus's cup-bearer.
Gorgons: Three winged sisters with snakes for hair; so ugly that whoever looked at them was turned to stone.
Hades (Pluto): God of Underworld; carried off Persephone, daughter of Demeter; also name of Underworld itself.
Harpies: Vultures with old women's heads who tormented men.
Hector: Trojan hero, son of Priam; killed by Achilles.
Helen: Wife of Menelaus, carried off by Paris to Troy; was the cause of the Trojan War.
Hephaestus (Vulcan): God of fire and of blacksmiths.
Hera (Juno): Daughter of Cronos; Queen of Heaven.
Herakles (Hercules): Greek hero; with help of gods, accomplished twelve labours.
Hermes (Mercury): Messenger and herald of gods. Also god of travellers, merchants, shepherds, and robbers.
Hydra: Seven-headed monster, killed by Hercules.
Hygieia: Goddess of health.
Hymen: God of marriage.
Hyperion: Father of Helios (Sun), Selene (Moon), and Eos (Dawn).
Jason: Captured Golden Fleece of Aeretes with help of Argonauts.
Leander: Youth of Abydos who swam Hellespont each night to see Hero, priestess of Aphrodite.
Medea: Daughter of Aeretes; helped Jason in his quest.
Medusa: A Gorgon; killed by Perseus.
Menelaus: King of Sparta, Agamemnon's brother, married Helen.
Mnemnosyne: Goddess of memory, mother of nine Muses.
Muses: Nine sisters who presided over the arts.
Narcissus: Gazed into a stream and fell in love with his reflection; was transformed into the flower called after him.
Nymphs: Lesser female deities; peopled whole of nature.
Odysseus (Ulysses): One of Greek leaders in Trojan War; invented the 'wooden horse'.
Oedipus: Son of Laius, King of Thebes; killed his father, tragically fulfilling prophecy made at his birth.
Orestes: Son of Agamemnon and Clytemnestra.
Orpheus: Tried unsuccessfully to reclaim wife Eurydice from Hades with the charm of his lyre-playing.
Pallas Athene: Goddess of wisdom, science and art.
Pan: Half man, half goat; god of shepherds.
Pandora: First woman, made by Zeus out of clay. Released all the ills of the world from her box.
Paris: Son of Priam; selected Aphrodite as most beautiful goddess; rewarded with Helen.
Parnassus: Mountain dedicated to Muses: also inhabited by Bacchantes.
Pegasus: Winged horse; sprang from head of Medusa.
Perseus: Killed Gorgon Medusa with help of gods.
Poseidon (Neptune): Brother of Zeus; king of the sea.
Priam: Last king of Troy.
Prometheus: A Titan who stole fire from Olympus and gave it to men.
Psyche: Beautiful nymph; beloved by Eros.
Satyrs: Spirits of woods and fields; devotees of Bacchus.
Sirens: Nymphs whose beautiful voices lured listeners to their death on rocks.
Styx: Chief river of the Underworld.
Themis: Goddess of law and justice.
Titans: Older race of giant gods.
Zeus (Jupiter): Replaced father, Cronos, as king of gods.

Right: A 3rd-century Roman mosaic from a villa in Cyprus. It shows Dionysus, the Greek god of wine and revelry, riding in triumph in his chariot. He wears vine leaves in his hair and carries a *thyrsus*. Dionysus is often shown attended by his retinue of *satyrs* (half men, half goats), *centaurs* (half men, half horses) and *maenads* (women driven mad with strong wine). His festival took place at the time of the grape harvest.

Photo: Sonia Halliday

Greenland has an inhospitable climate and the population is sparsely scattered around the south coast. Most of the people are fishermen. They live in houses with steeply sloping roofs, like those pictured above. These prevent too much snow accumulating on them in winter.

Greenland is the largest island in the world. Most of it lies north of the Arctic Circle and is largely covered by ice and snow. The only 'Green' land is a narrow strip around the coast. Most of the settlements lie on the narrow western coastal strip. Thule, a town in the north-west, houses a United States anti-missile defence base, completed in the early 1960's. Greenland belongs to Denmark, and since 1953 it has been a Danish county.

The island's coastline has many inlets called *fiords*. Northern Greenland has no sunshine during the cold winter. But during the cool summer, the sun never sets and it is never really dark. In summer, mosses and flowers grow near the coast. Reindeer roam over the hills eating the moss. Polar bears fish in the ice-covered lakes. The sea near Greenland teems with shoals of cod. Minerals found in Greenland include uranium and zinc and an aluminium-containing substance called *cryolite*. But the snow, ice and frozen ground prevent mining in most parts of the island.

Most Greenlanders are descended from Eskimos. Most of them are fishermen and fish is their main food. The rest of the people are Europeans, mainly Danes, who work in government and commerce.

A location map of Greenland.

Apart from mining and fishing, the chief industries are fish-canning and fish-freezing. At one time, Greenlanders lived by hunting seals.

The Danes began to colonize Greenland in the early 1700's. They held it against Norwegian claims in the 1930's. In January 1968, an American aircraft carrying hydrogen bombs crashed near Thule. The bombs did not explode and all the parts of the bombs were recovered.

Facts and Figures
Area: 840,001 square miles.
Population: 49,000.
Capital: Godthaab.

Greenwich is a Greater London Borough, in the south-east of London, on the south bank of the Thames. It is connected to the north bank by the Blackwall Tunnel (for vehicles) and the Greenwich Tunnel (for pedestrians).

Greenwich is chiefly known for the Greenwich meridian and Greenwich Mean Time. The astronomers who worked at the Royal Greenwich Observatory, founded in 1675, made their calculations of longitude using an imaginary line passing through the Observatory as 0 degrees. In 1884 an international conference of astronomers in Washington adopted this Greenwich *meridian* for universal use. Greenwich Mean Time (GMT) is the time on the meridian as calculated by an atomic clock, which is regularly checked against the movement of the stars.

Grimm was the name of two German brothers, Jakob Ludwig Karl Grimm (1785-1863), and Wilhelm Karl Grimm (1786-1859), who wrote one of the world's most famous books—a delightful collection of stories known as *Grimm's Fairy Tales*.

A view of the Royal Observatory situated in Greenwich Park, near London. The people are standing by the meridian. The position of the meridian was chosen because it went through the position of a telescope.

The Grimm brothers collected and wrote down 156 fairy stories in all. These were published in two volumes in 1812 and 1815. 'Little Red Riding Hood', 'Sleeping Beauty', 'Cinderella' and 'Puss In Boots' were among the many famous tales which they were responsible for making known to children the world over.

The brothers were both *philologists* (specialists in the science of language) and both eventually became university professors. They wanted to preserve the old German folk legends and myths that had been handed down from generation to generation. They wrote many of the stories exactly as told to them by people they met in the towns and the countryside. The tales took seven years to collect. The brothers made characters such as Hänsel and Gretel, Snow-White and Rumpelstiltskin famous throughout the world.

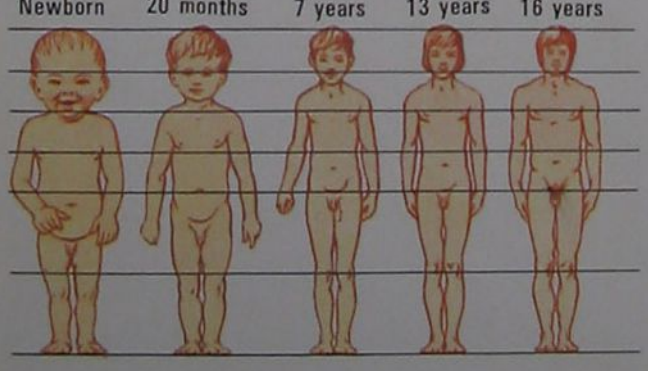
The brothers were inseparable companions and lifelong collaborators. Their deep love for their country led them to other studies of its language, history and literature. One of their projects was an immense dictionary of German, which was not finished until long after their deaths. Jakob also published important works on grammar.

Growth All living things *grow*, or increase in size. At the same time they mature—that is, they become more adult in form and behaviour. Eventually, most animals reach a point of maximum growth. Human beings, for example. generally stop growing when they reach the age of 16. But certain animals, such as coral polyps, continue growing for as long as they have adequate supplies of food, water, light and other essentials. Many green and non-green plants also continue to grow throughout their lives.

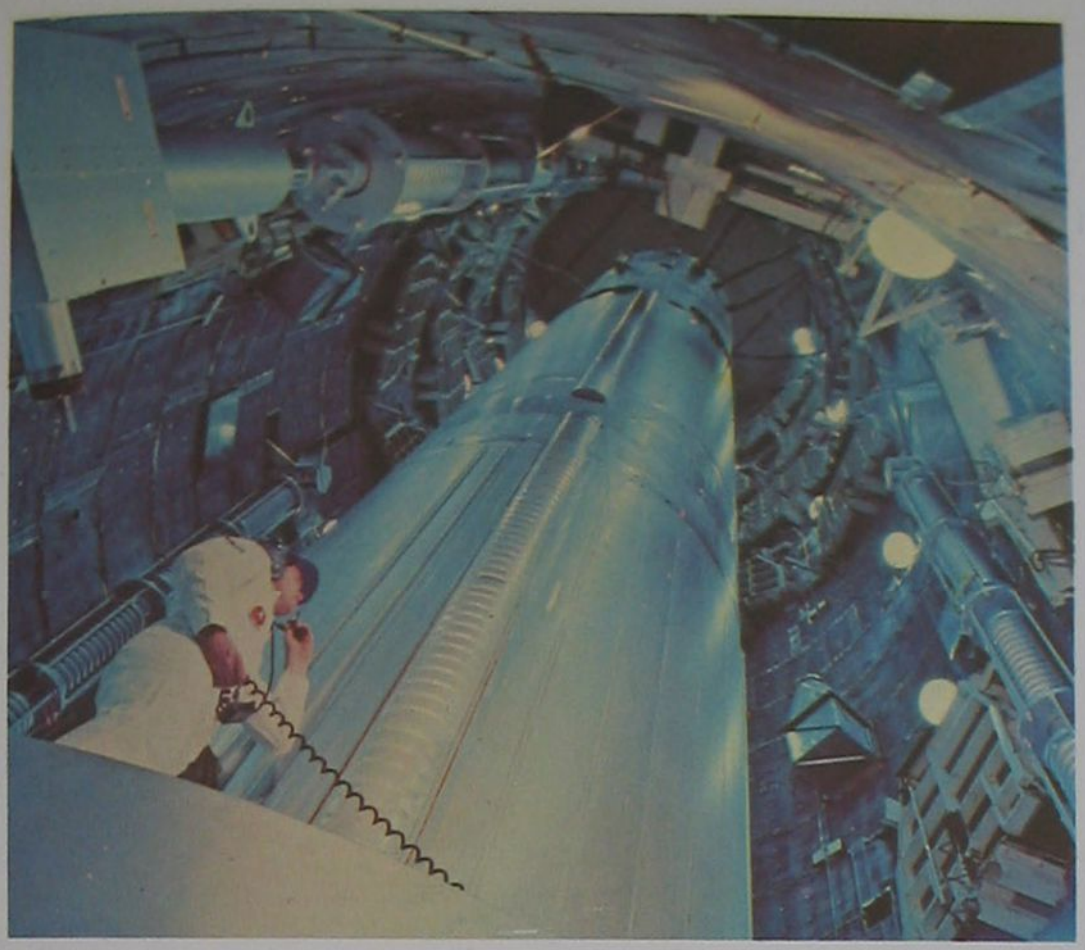
Growth is regulated chiefly by *heredity*. Heredity makes sure that the process of growth is orderly and predictable. Each animal or plant organism begins as a single cell, which divides and multiplies to form a group of cells. These eventually *differentiate* (develop in separate ways) to form the various tissues and parts of the body. Heredity limits the size to which each particular kind of organism grows. For example, a cat does not grow as big as a horse. But whether the full potential size is reached depends on other factors, such as hormones and nutrition. In human beings, poor diet, or malfunctioning of the pituitary, thyroid or sex glands can disturb growth (see Glands).

Growth is almost always an uneven process; periods of rapid change alternate with times of little change. The process can be charted as a *growth curve*. The human growth curve shows the most rapid development in the first two years of life, with another spurt during adolescence—that is, from the age of about 12 to about 20. During the second period of rapid growth people reach sexual maturity.

The most extreme example of uneven growth is the process of *metamorphosis*, which takes place in butterflies, moths, frogs and other kinds of insects and amphibians. These animals change in appearance as they become adult. A frog, for example, hatches from its egg as a tadpole, a creature that lives under water and looks like a tiny black fish. As it



This diagram shows how growth is an uneven process. An adult has different proportions from a newborn baby. A baby's head is huge in proportion to his trunk and limbs. By the time a child is about ten or eleven years old, his skull will have reached its full size, although his 'face' will continue to grow. The arms grow at much the same rate as the body. If they did not, the child would have difficulty in feeding itself and performing other essential functions. The legs are the last part of the body to grow to maturity. This process usually happens in the early teens. For this reason, children tend to grow several inches in height in a short time during this period of their life.



An Atlas missile in its *silo* (underground launching pit). Guided missiles form an essential part of the defences of the United States.

grows, it develops into the air-breathing, four-legged, tailless adult frog.

During the process of growth, the various parts of the body develop at different rates. As a result, the proportions of the body change. The head of an infant human being is proportionately much larger than the head of an adult. But the head grows very little, while the trunk and limbs increase to several times their original size.

Even when the body as a whole has stopped growing, the cells and tissues of the body continue to grow. Cells are wearing out all the time and must be replaced.

Guatemala is a republic in Central America. It is a land of mountains and jungles, with coastlines on both the Caribbean Sea and the Pacific Ocean. Its area is 42,042 square miles. Guatemala depends on the growing of coffee and cotton. Timber and quinine are also exported. Guatemala City, the capital, has some industry. About half of Guatemala's 5,014,000 people are descended from the Maya Indians. The Maya civilization was destroyed by the Spanish in the 1500's.

The fastest growing creature of the Animal Kingdom is the calf of the blue whale. In 10¾ months of gestation and the first 12 months of its life, it grows from a microscopic egg cell to a weight of about 26 tons.

Guided Missiles are among the most advanced weapons of modern warfare. They are really self-propelled bombs.

Guided missiles look like huge darts. The smallest are about 10 feet long. Others are up to 100 feet in length.

Every guided missile has three main

A location map of Guatemala.

parts. The first is the *warhead*—the nose of the missile, containing the bomb.

The second part is the *propulsion system*. This launches the missile from its pad and keeps it flying. Most guided missiles are propelled by rocket engines.

The third part is the *guidance and control system* that brings the missile to its target. Some missiles are controlled from the ground, where the best course is calculated on computers, and instructions are sent to the missile. This system is known as *command guidance*.

Other missiles have computers on board. Some are pre-set to hit a definite target, such as an enemy city. Other missiles are built to follow a radar or radio beam. Still other missiles have *homing* mechanisms—that is, they are attracted by heat, sound or some other quality of the target.

Surface-to-air missiles are shot from the ground, or a submarine or other ship to targets in the air. *Air-to-surface* missiles are shot from planes to targets on the ground or the sea. *Surface-to-surface* missiles fly from the ground or a ship to another ship or a spot on land. *Air-to-air* missiles are shot from a plane to another flying target.

Short and *medium range* missiles are used against enemy tanks, planes or installations from less than 100 yards to hundreds of miles away. *IRBMs* (*I*ntermediate *R*ange *B*allistic *M*issiles) have ranges of about 1,500 miles. *ICBMs* (*I*nter-*C*ontinental *B*allistic *M*issiles) have ranges of over 5,000 miles.

The best defence against a guided missile is an *ABM* (*A*nti-*B*allistic *M*issile). But even these are powerless against multiple warhead weapons that release a shower of small missiles.

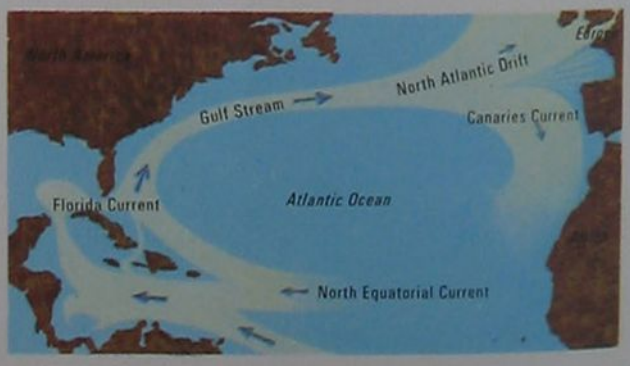
A location map of Guinea.

Guinea is a republic in the bulge of western Africa. Conakry, its capital, is a port on the Atlantic Ocean. Portuguese Guinea, Senegal, Mali, Ivory Coast, Liberia and Sierra Leone border the country. Guinea has an area of 94,926 square miles. It has a varied landscape—coastal swamps and plains, grassy river valleys, mountains and forests. Fulani, Malinke and other African tribes live in Guinea. Most of the country's 3,890,000 inhabitants are farmers. Guinea exports bananas, coffee and nuts. The country has deposits of iron ore and bauxite (aluminium ore).

Guinea was a French colony until 1958.

Gulf Stream This is the ocean current that flows north-east across the Atlantic Ocean from Florida in the United States. The Gulf Stream is part of the generally clockwise circulation of water in the North Atlantic. The North Equatorial Current combines with water from the Gulf of Mexico. They pass Florida at a speed of about 80 miles a day. This current of warm water then flows along the coast of America, separated from it by a strip of cold water, as far as Newfoundland, where fogs are caused as

Below: Map showing the course of the Gulf Stream which flows north-east across the Atlantic Ocean. Its waters warm passing winds and give North-West Europe a relatively mild winter climate.



warm winds meet cold water from the Arctic. The Gulf Stream then spreads out into a slow drift of warm water across the Atlantic, called the North Atlantic Drift.

When the Drift meets the continental shelf of Europe, it divides in two. One branch flows south towards Africa. The other flows around the coasts of north-west Europe, affecting the climates. If it were not for the Gulf Stream, winter in countries from France and Britain to Norway would be much more severe. Harbours would ice up and snow would lie on the ground all winter. (See Ocean Currents.)

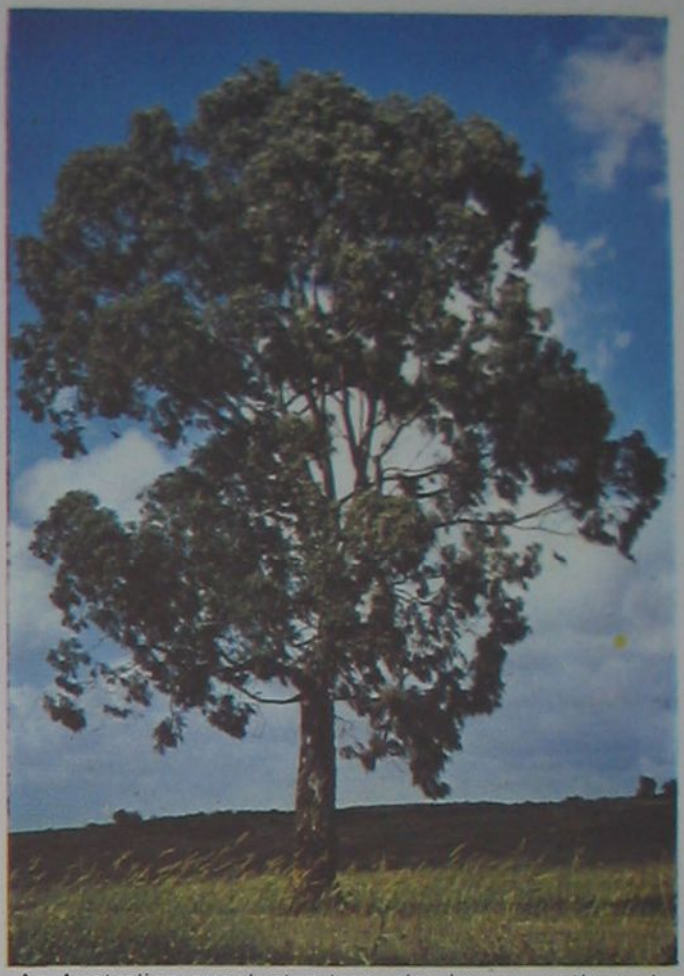
Gum trees are trees that produce a vegetable substance known as gum. This is similar to resin but it can be dissolved in water which resin cannot. The most common gum tree is the sapodilla which grows in many parts of Central and South America.

This produces chicle gum from which chewing gum is made. The Australian eucalyptus, the North American tupelo and the African acacia are also known as gum trees. Gum is obtained from plum, peach and cherry trees. It is often used to make glue.

Guns The term *gun* is generally applied to all kinds of firearms, from hand pistols to heavy artillery.

The main kinds of small-arms are pistols, shotguns, rifles, and machine-guns. They all work on the same principle. They have a long barrel, of which one end (the *breech*) is closed and the other end (the *muzzle*) is open. A cartridge placed in the breech is fired by pressing a trigger. This action releases a firing pin or hammer against the base of the cartridge, thus setting off a percussion cap.

This fires the charge of gunpowder or other explosive inside it. The gases produced drive a bullet, or lead shot (pellets), up the barrel.



An Australian eucalyptus tree, also known as the red gum. The tree is valuable for its timber and also for its leaves, from which the medicine eucalyptus oil is produced.

Most guns, except the sporting shotgun, have *rifled* barrels, which have spiral grooves on the inside. These spin the bullets and makes them go straighter. They may leave the barrel at speeds greater than 2,000 miles an hour. In machine-guns and automatic rifles and

Below: 'Mons Meg', a famous fifteenth-century cannon now in Edinburgh castle. It was forged in Flanders in 1486 and was used in the sieges of Norham and Threaves Castles. It burst while firing a salute in 1680.

Left: German troops in World War II using a field mortar. A mortar is a special type of gun used for throwing a bomb-like shell which explodes into small fragments on impact. It is loaded by dropping the shell into the muzzle. It is used to attack an enemy who is entrenched behind cover which small arms, i.e. rifle and machine-gun fire, cannot reach. It is the equivalent, at infantry level, of the howitzer which throws a shell in a high arc, thus overcoming obstacles. Smoke shells are also used with the mortar to provide cover for advancing troops. Skilled mortar men can sustain a rapid rate of fire with considerable accuracy.

Above: British troops practising the use of the 'Wombat' Battalion Anti-Tank Gun. This weapon is highly accurate and has tremendous power, and is capable of knocking out a very heavy armoured fighting vehicle. Guns such as the 'Wombat' which are mobile but which also have great power are important in modern armoured warfare.

pistols, the cartridges enter the breech and are automatically ejected after firing.

Most shotguns have two barrels side by side. They are smooth because they fire lead shot, not bullets.

Early guns had smooth barrels, too. They first appeared in the late 1300's, not long after the cannon, and just over 100 years after the invention of gunpowder. These hand 'cannons' were made and fired in the same way as cannons.

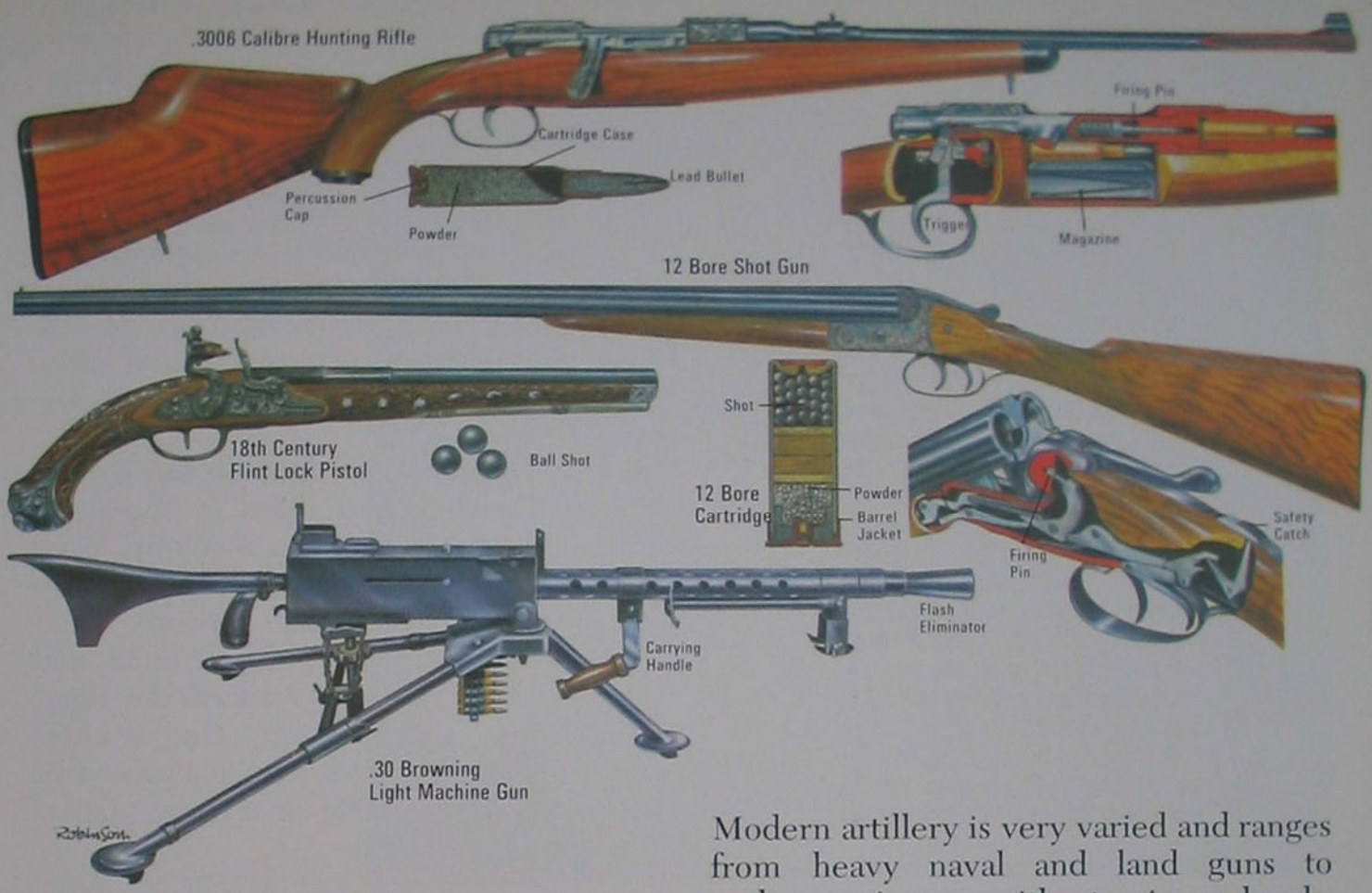
The charge of gunpowder was poured into the barrel and a metal ball placed on top of it. It was fired by touching a burning taper to a powder-filled *touch hole* in the breech. Early models were so crude that they were more likely to kill the firer than the enemy.

The early *muskets*, as these guns were called, were supported during firing with a forked staff. Later they became more recognizably guns as we know them today. Improvements came in the method of firing the charge. In the late 1400's came the *match-lock*, which was a trigger-operated device for moving a slowly burning cord, or match, to the touch hole. In the 1500's, came the *wheel-lock* and *flint-lock* which produced 'instant' sparks to ignite the powder. The flint-lock soon proved to be the best system. And practically all firearms until the early 1800's had it.

Rifled guns had been used as far back as 1500. But they were not widely used until the late 1700's. At about the same time a method of breech-loading was developed. The invention in the early 1800's of a percussion cap to explode the charge soon lead to the use of separate cartridges.

During the opening up of the American West, gun-making advanced rapidly. Samuel Colt built the first true revolver in 1835, but the earliest models were muzzle-loading. The famous Army Colt .45 appeared in 1872. Remington and Smith & Wesson revolvers were also popular weapons among the 'gun-slingers' of this time. Oliver Winchester produced his famous repeating rifle in 1873.

The invention in the late 1800's of the breech bolt, a clip or magazine to load the cartridges, and smokeless powder led to the development of the gun in its present form.



Above: A range of weapons from an ancient flintlock pistol firing solid metal balls to a modern machine-gun capable of sustaining a rapid rate of automatic fire.

Artillery first appeared at the Battle of Crécy in 1346 but it was not an effective factor in the fight. Many years passed before any decisive use was made of the new arm—when King Henry V of England captured Harfleur in 1415 and proved the vulnerability of medieval fortifications to large guns. Even so, many years were to pass before artillery became fully mobile and could be used to defeat massed infantry. This happened at the Battle of Marignano in 1515 when the famous Swiss pikemen, believed almost invulnerable, were broken and turned back by fire power. It was Napoleon who brought the use of artillery to a peak of its destructive power, however. Since Napoleon the tactical use of artillery, as well as its technical efficiency, has undergone tremendous changes, but mobility and close co-operation with infantry remain the keys to its effectiveness. Modern artillery is very varied and ranges from heavy naval and land guns to rocket projectors with atomic warheads.

Talking points

*Do you think that ordinary citizens should be allowed to buy and keep guns without any restrictions?

*Guns are dangerous weapons. Do you think that young children should be encouraged to play with toy guns?

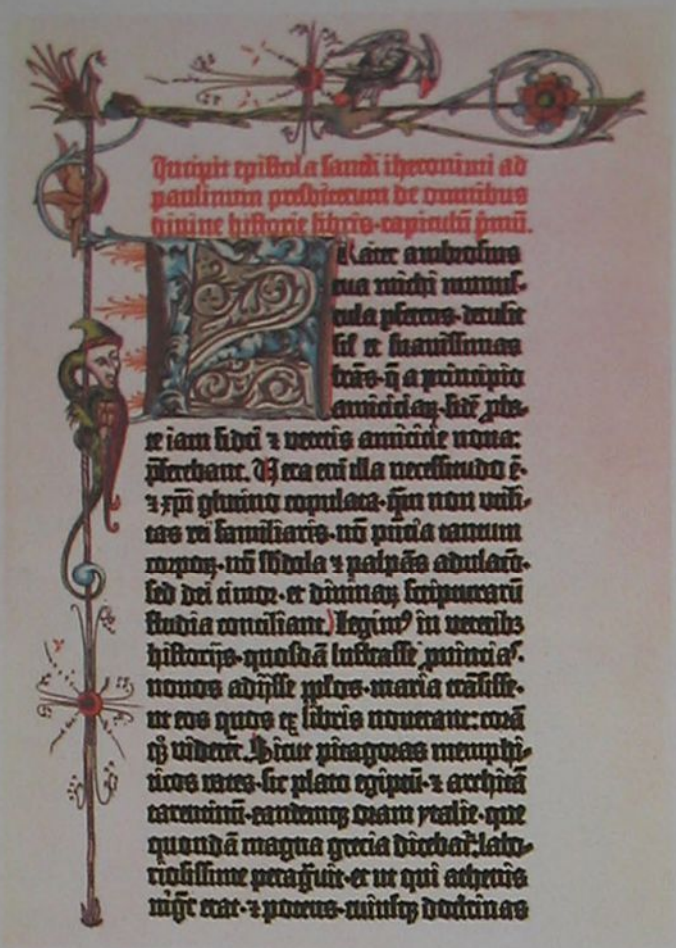
*Remember that you must never point a gun at anyone in fun. Even if you know that it is unloaded, you must always keep the barrel pointing at the ground or at the sky if there are people near you.

Articles to read

Armed Forces; Ballistics.

Gutenberg, Johannes (1397?-1468), a German from the city of Mainz, invented the first practicable method of printing by using movable metal *type* (letters). His invention made printed books more widely available. Previously, books had been extremely costly, because they had either to be copied by hand or else made from woodcuts of entire pages. Although the Chinese and Koreans had developed a system of movable type earlier, their technique was unknown to Gutenberg.

Gutenberg designed moulds into which metal was poured to make the letters, and constructed a press in which the paper was pressed firmly against the inked type. He also developed a suitable metal for



A page from one of the few surviving copies of Gutenberg's Bibles. It was printed in Latin using the *Gothic* type that was still used in Germany until quite recent times. Each letter of type was made by hand.

his needs, an *alloy* (mixture) of lead, tin and antimony. He experimented with inks until he made one that transferred cleanly from the type to the paper. Gutenberg's most famous works were his Bibles.

Guyana is an independent republic in South America. Georgetown is its capital and largest city Venezuela lies to its west, Brazil to the south and Surinam to the east.

Guyana covers an area of 83,000 square miles. Only 714,000 people live there. But the coastal area, where most people live, is very crowded. Small numbers of native American Indians inhabit the thick rain forest of the interior.

Guyana is principally an agricultural country. Sugar-cane is the chief crop. Rice, coffee and cocoa are also grown. *Bauxite* (aluminium ore) is the most valuable mineral. Some gold and diamonds are mined.

Guyana was settled first by the Dutch. The British expelled them in the early 1800's and made the area a colony. They called it British Guiana. The British brought African slaves, servants from Portugal and labourers from India and China to the colony to work on the sugar plantations. As a result, the country has a mixture of races. Guyana gained its independence in 1966. It is a member of the Commonwealth.

A location map of Guyana.

Gymnastics is a form of sport in which balance, co-ordination, rhythm and strength play a great part. It consists of various floor exercises—including hand balances, cartwheels, jumps and tumbling—and events on various kinds of gymnastic equipment. The sport originated in ancient Greece, and the words gymnastics and *gymnasium* (an indoor hall for sports activities) come from a Greek word.

In its modern form, gymnastics developed during the 1800's in Sweden and Germany. The Swedish floor style and the German bar or turning style gradually combined, and the sport spread to other countries. In many of them it is chiefly used in schools and the armed services to keep up physical fitness. But in Russia, Japan, Czechoslovakia and some other countries, it is considered a major sport. These countries usually lead in international competitions, including the Olympic Games. Czechoslovakia, Germany, Sweden and Switzerland also hold

Olga Korbut, the Russian gymnast, performs on the beam at the 1972 Olympic Games. She won the gold medal for this event and another one for the floor exercise. She was only 17 years old at the time.

regular large gymnastic festivals of their own.

Although gymnastics is a sport in which many kinds of events are possible, some events have now become standard for world competition. Men compete on the *hanging rings*, the *vault*, the *pommel horse*, the *horizontal bar* and the *parallel bars*. The gymnasts jump and turn and perform holds that require strength in the arm and shoulder muscles. Floor exercises must be executed smoothly and perfectly. A separate score is given for a *combined exercises* event.

Women also do *floor exercises*, for which they have a musical accompaniment. The performer must show graceful style as well as perfect control, and this kind of gymnastics looks rather like ballet dancing. Women also compete on the *vault*, the *balance beam*, the *high and low bars* and in a *combined exercises* event.

Gypsies are a wandering people found in small scattered groups throughout Europe and Asia. They called themselves *Roma* and spoke a language known as Romany. Originally they came from a caste of Indian people and their language was related to Sanskrit.

When some Gypsies went to Britain around the year 1500 they referred to themselves as Egyptians, and the name *gypsies* comes from this word. Nowadays, the word is used loosely to describe wandering people who live in groups.

Gypsies have always been regarded with suspicion, and many were killed in Germany during World War II. There are probably no more than 2,000 true Gypsies in Britain today. The women are more important in the group than the men. Children once took the mother's name, not that of the father—but this is no longer the rule. It is the Gypsy Queen, however, who is most important, and the women generally rule the family. They tell fortunes and prepare medicines and remedies from herbs and plants. In Britain Gypsies often make their living by

dealing in scrap metal. They now live in comfortable modern caravans. The old painted, horse drawn caravans are regarded as valuable antiques. Very few Gypsies now speak the original Romany language, though a few words and phrases still survive. Some Gypsy words are said to have crept into the English language. 'Dad' is said to be the original word for 'father', and the slang word 'shaver' is believed to have come from 'chaver' meaning 'child'.

Gypsies are found all over Europe, especially in Spain where they are famous for their wild *flamenco* dancing and their guitar playing. When the Gypsies first came to Europe in about 100 A.D. they were treated with respect because of supposed biblical connections. They have always been thought to be mystical people and some of them still make a living by telling fortunes at fairs.

A model gyroscope. The fact that the wheel keeps the axle in the same direction when spinning, makes the gyroscope a valuable stabilizing device.

Gyroscope This device has a metal wheel that spins like a top inside a frame. Engineers use gyroscopes to help steer aircraft, rockets, ships and torpedoes. They can also be used to stabilize rockets and ships, stopping them from pitching and rolling.

The wheel, or *rotor*, of a gyroscope is mounted on an axle. Once the rotor is spinning, the axle stays always pointing in the same direction. This is the principle of the gyro-compass. If you try to push the axis into a different direction, it will resist the push and move back to its original position. This is the principle of the gyro-stabilizers on ships.

H

Habsburg or *Hapsburg* is the name of a European royal family that ruled Austria-Hungary until 1918. The Habsburgs were Holy Roman Emperors from 1438 to 1806, and a branch of the family held the Spanish throne for nearly 200 years until 1700. They took their name from a fortress in what is now the Swiss canton of Aargau. Its name, *Habichtsburg*, means hawk's castle.

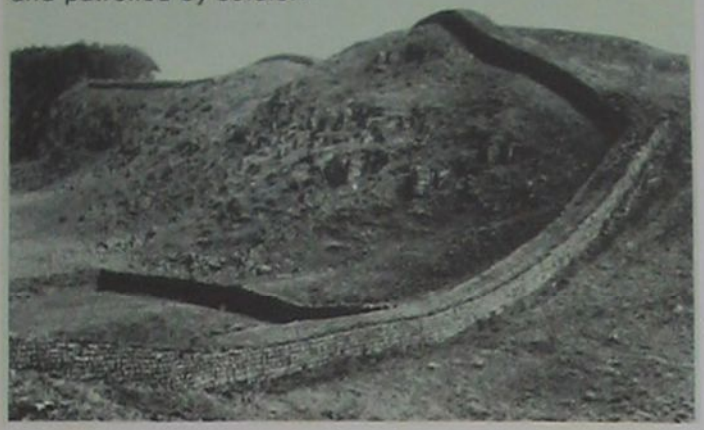
In 1273, Rudolf, count of Habsburg, became Holy Roman Emperor. He added Austria and Styria to his family possessions. Two later members of the family also became Roman Emperors, but until 1437 the Habsburgs were important chiefly as dukes of Austria. In that year, Albert of Habsburg inherited the kingdoms of Hungary and Bohemia from his father-in-law, Sigismund, and in 1438 was chosen German king and emperor. Although in theory each new emperor was freely chosen by the seven electors, in practice the Habsburgs kept the imperial throne, with a few short breaks, until 1806. In that year, Napoleon abolished the Holy Roman Empire.

The Habsburgs remained Emperors of Austria. In 1867, Hungary was formed into a separate kingdom, and their empire was called Austria-Hungary. The last Habsburg ruler was Charles I, who abdicated in 1918 at the end of World War I.

Hadrian's Wall was built between A.D. 122 and 130 on the orders of the Roman

Right: A family of Gypsies. They now often live in comfortable modern caravans, but many still live a wandering life.

Below: Part of Hadrian's Wall which formed the main defence work in Britain in Roman times. From this well-nigh impregnable position the Roman armies held back the wild tribes of the north and prevented them from over-running England. It remained in use as the principal fortification for over two hundred and fifty years. It was actually a chain of small forts linked by massive stone and earthworks constantly manned and patrolled by soldiers



Emperor Hadrian. It stretched for 73 miles across northern Britain, from Wallsend on the River Tyne to Bowness on the Solway Firth.

Roman soldiers built the wall which is mainly 8 feet thick and 20 feet high. There were seventeen forts along its length, each built to house 500 to 1,000 soldiers. These forts had officers' quarters, barracks, granaries and workshops. The remains of one can still be seen at Housesteads. Smaller forts (mile-castles) were built every Roman mile. These held 40 soldiers. Between each mile-castle were two signalling towers. A road ran just inside the wall to link up all the forts. Further south, a large ditch and earthworks (the 'vallum') showed the edge of the military zone.

The wall marked the boundary of Roman rule in Britain. Soldiers patrolling the wall could hold in check the wild tribes who lived to the north, and close the frontier in time of trouble. The wall was finally abandoned in A.D. 383.

Hague, The ('s Gravenhage) is a city of the Netherlands (Holland). It is the seat of government, an administrative centre, the Royal residence, and the site of a permanent court of international justice.

Hail consists of ice pellets that fall to earth during thunderstorms. Droplets of water are carried up and down the freezing levels of clouds by strong air currents. They take on fresh layers of ice until they fall as hailstones. Hailstones range in size from a fifth of an inch to two inches or more in diameter. The heaviest hailstone recorded fell in Kansas, U.S.A. It was 7½ inches across and weighed 1.67 pounds.

Haile Selassie (1892-), emperor of Ethiopia, is one of Africa's leading statesmen. He was mainly responsible for forming the Organization of African Unity and the United Nations Economic Commission. Both these organizations are based in Ethiopia. He worked to raise the level of education and income of his people, and he abolished slavery. In 1955, he granted Ethiopians a written constitution. This allowed them to elect representatives for the first time.

The emperor took the name Haile

Haile Selassie, the emperor of Ethiopia. Among his other titles he is known as 'the Lion of Judah'. Ethiopia was the first African country to be converted to Christianity.

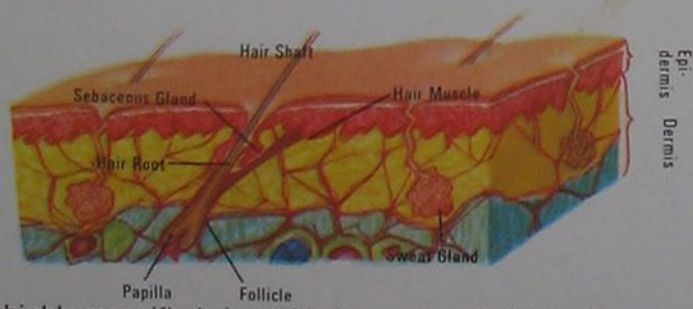
Selassie when he assumed the throne in 1930. His real name was Tafari Makonnen. He was the grand-nephew of emperor Menelik II and became regent and heir in 1916 when Menelik's daughter, Zawditu, became empress. He became emperor when she died.

The new emperor's plans for reforming his country were halted in 1935 when Italy invaded the country.

Hair grows from the skin of mammals. The fur of a rabbit, the bristles of a pig, and the spines of a hedgehog are all kinds of hair.

Hair has various functions. It helps the body to keep an even temperature by trapping a layer of air next to the skin. It protects animals from injury and, through its colouring, helps in camouflage. Some hairs, such as a cat's whiskers, have extra nerves and act as sensitive 'feelers'.

A hair consists of two parts, the *root* and the *shaft*. The swollen root is embedded in a tiny pit, called a *follicle*, in the skin. At the very bottom of the follicle is a bump called the *papilla*. This contains the hair's blood supply. Hair cells grow from the papilla. They push older cells upwards, and these die and become part of the hair's shaft. Hair is made of the same material that forms nails, claws and hoofs in mammals; feathers in birds; and scales in reptiles.



A highly magnified view of hair growing. It shows the root and shaft of the hair rooted in the follicle in the skin.

Haiti is a mountainous country occupying the western third of the island of Hispaniola in the West Indies. Its capital is Port-au-Prince. The vast majority

A location map of Haiti.

of Haiti's 4,768,000 people are Negroes, descended from slaves brought from Africa. The country's area is 10,714 square miles. The climate is tropical. Coffee, sugar-cane, sisal and cotton are grown in the hills and on the fertile plains. Loggers cut fine timber from the forests.

Haiti belonged to Spain, then to France. It became an independent republic in 1804.

Halloween is the evening of October 31, the eve of All Saints Day (November 1). Its name means hallows evening. The ancient Druids had an end-of-summer feast on this date, when witches and ghosts were believed to be about. Later, the festival became associated with the Christian day of All Saints, or All Hallows.

In many parts of the world Halloween is a day for parties. Old Halloween customs include wearing masks, lighting bonfires and bobbing for apples. Children play pranks and go to visit friends carrying jack-o'-lanterns—hollow pumpkins or turnips in which faces have been cut and containing lighted candles.

Hamburg is a prosperous seaport and commercial and industrial city of northern Germany. With a population of 1,818,000, it is the second largest German city after Berlin. As the country's chief port situated on the wide River Elbe 70 miles from its outlet to the North Sea, it is visited by cargo and passenger vessels from almost all ports of the world and

Ponies graze in the New Forest, one of the chief tourist attractions in Hampshire, England. The New Forest is about 144 square miles of deciduous woodland and open heath in the south-west of the county. Most of it is Crown property. The New Forest Ponies are not wild, but are allowed to roam free for most of the year.

has an immense transit trade. Engineering, shipbuilding and food processing are but a few of the city's many industries.

The Alster is a lake-like expansion of the river extending to the centre of the city. In summer it is alive with small boats.

Hampshire, on the south coast, is one of England's most beautiful counties, with well-wooded and gently rolling countryside. The New Forest, in the south-west, is one of the oldest areas of woodland in England. In the north are the low hills of the Hampshire Downs, and in the south-east the South Downs extend into Hampshire from Sussex. The Isle of Wight lies just offshore in the stretch of water called the Solent. Hampshire's rivers include the Itchen, Test, Hamble and Avon. The area of the county is 1,500 square miles and its population is 1,561,000.

Southampton, on the inlet called Southampton Water, is one of Britain's chief ports, and Portsmouth and Gosport have long been connected with the navy. The many seaside resorts include the famous holiday and residential town of Bournemouth. Hampshire is chiefly agricultural, but also has thriving industries, including food processing, and the manufacture of chemicals, transport equipment and electrical goods. The oil refinery at Fawley is one of the most important in Europe. The county town of Winchester was the capital of England under Alfred the Great.

Handel, George Frideric (1685-1759), a German-born composer, produced his greatest works in Italy and England.

Handel's father arranged his musical education, but wanted him to be a lawyer. After his father's death, Handel obeyed his father's wish and completed his degree in law. But he abandoned law in 1703 to join the orchestra of the Opera House at Hamburg. By 1704, two of his operas, *Almira* and *Nero*, had been successfully performed. At the Opera House, Handel quarrelled with Mattheson, another young musician. They fought a duel, which ended when Mattheson's sword broke.

Italy being the centre of musical activity at this time, Handel went to live there in

1706 to perfect his art. He was a great success and made the Italian style of opera and *oratorio* (a religious work for singers and orchestra) his own. His opera *Agrippina* in Venice (1709) won the admiration of the great Italian composer Alessandro Scarlatti.

Handel returned to Germany triumphant and secured the post of music director to the Court of Elector Georg of Hanover in 1710.

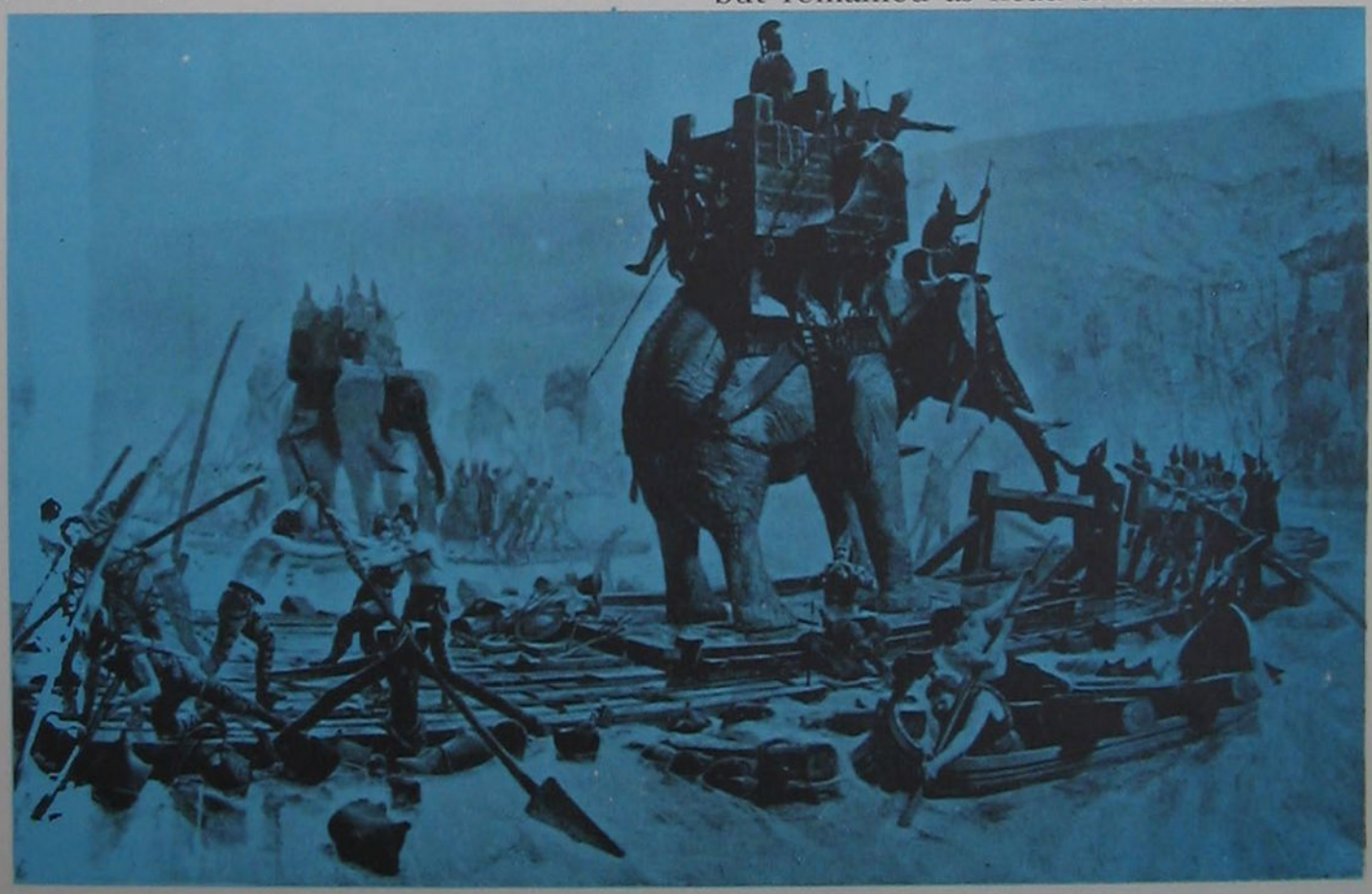
In 1712, he decided to live in London permanently. The Elector was crowned George I of England in 1714 and he supported Handel with his patronage. Handel introduced the English style of oratorio, which reached its greatest height in *Messiah* (1742), and provided London with glorious operas and keyboard music of a mixed Italian/German style, flavoured with English directness.

In 1751 his eyes began to trouble him and two years later he was blind. At his death, he was the greatest composer the English had known since Purcell, and they were not to know another for 150 years.

Hannibal (247-182 B.C.) was the most skilful general that the Romans had to fight when they were building up their empire. The Romans ordered him to stop increasing the empire of the African city-state of Carthage. He replied by crossing the Alps from France into Italy and defeating them in many battles. He used brilliant tactics, but he was unable to destroy the great power of Rome.

Hannibal showed great courage in crossing the Alps in 218 B.C. because almost everybody said it was impossible. He took a large army, with many elephants, and lost three-quarters of it. Luckily, he was able to get soldiers from the Gallic tribes of northern Italy. In 216 B.C. he crushed a large Roman army at Cannae, in south-eastern Italy. His brother Hasdrubal came from Spain with new troops, but was killed by the Romans. In 204 B.C. the Roman consul Scipio invaded Africa, so Hannibal was recalled to Carthage. He was defeated by Scipio, but remained as head of the state.

Hannibal ferrying his elephants across a river on his journey to Italy.



In 195 B.C. the Romans forced Hannibal into exile. He went to Asia, and when the Romans said he should give himself up, he killed himself by poison.

Hanseatic League was a medieval association of cities of northern Germany, that banded together to protect and promote their trade. Its name came from the German word *hanse*, meaning a traders' union. Hamburg, Hadeln and Ditmarsh were the first cities to associate in this way, in 1219. Shortly afterwards, Lübeck and Brunswick joined. The original aim was to guard against piracy, but in time the League gained control of most of the trade of northern Europe. It then acted almost as though it was a political state.

At the height of its power, in the 1300's, the Hanseatic League had about 70 members, including most of the trading cities of the Baltic Sea and of the North Sea. Its chief members were Lubeck and Cologne.

The League developed orderly systems of mercantile law and weights and measures. It made treaties with the countries in which its members had trade interests, and was able to enforce agreements by means of its army and navy. From 1360 to 1370 it was at war with Denmark, which disputed the League's rights in the waters between the Baltic and North Seas. The League was victorious, and for a time claimed authority to appoint the Danish King.

The League began to lose its power in the 1500's, partly because of national rivalries and also because of changes in the direction of trade after the discovery of the Americas. By 1628, its only active members were Lübeck, Bremen, and Hamburg.

Hare see Rabbit.

Harold was the name of two English kings.

Harold I (?-1040), called 'Harefoot', was the son of Canute, and succeeded his father in 1035. At first, he had to share the kingdom with his half-brother Hardicanute. But in 1037 he became sole king.

Harold II (?1022-1066) was a son of Earl Godwin and a brother-in-law of Edward the Confessor. When Edward died in 1066, the *Witan* (council of nobles) chose Harold as king. Almost at once, his brother Tostig and the Norwegian King Harold Hardrada invaded England, and so did William, Duke of Normandy. Harold defeated and killed Tostig and Harold Hardrada at Stamford Bridge on September 25, but was himself defeated and killed by William and his Normans at Hastings on October 14. With Harold's defeat began the long Norman rule of England that was to change the whole course of the country's history.

Hartog, Dirk, a Dutch seaman who lived in the 1500's, was the first European known to have landed on the continent of Australia. He was employed as a ship's captain by the Dutch East India Company and set out for the East Indies in a ship called the *Eendracht*. Hartog rounded the tip of Africa, but then followed a course that took him too far south. In October 1616 he sighted the western coast of Australia. He landed on an island in Shark Bay that is now named after him.

To mark his visit, Hartog fastened a pewter plate to a post, and scratched his name on it. The plate was later found by other navigators. It now rests in a museum in Amsterdam, in the Netherlands.

Hastings, Battle of, was fought on October 14, 1066 between Norman invaders of England under William, Duke of Normandy and an Anglo-Saxon army under Harold II. It changed the whole course of English history. Harold, who had defeated a Norwegian attack three weeks earlier, positioned his army on a hill at the place now called Battle, near Hastings. There was heavy fighting all

The Bayeux tapestry shows the final stages of the battle of Hastings. On the right of the picture, King Harold receives a fatal arrow in his eye; while on the left the Norman knights charge the last few of his *house carls* (personal bodyguard). The frieze at the bottom of the tapestry shows the victorious Normans stripping the armour from the fallen Saxons.

day. In the evening Harold was killed by an arrow which hit him in the eye, and the Saxon army fled. The Normans were then able to conquer England without further opposition. William, called *William the Conqueror*, was crowned king in Westminster Abbey on Christmas Day, 1066.

Hawaii, a group of more than 20 islands in the Pacific Ocean, became the fiftieth state of the United States in 1959. The islands lie more than 2,000 miles southwest of the United States mainland.

A location map of the Hawaiian Islands.

In order of size, the eight largest islands are Hawaii, Maui, Oahu, Kauai, Molokai, Lanai, Niihau and the uninhabited Kahoolawe. These islands have an area of 6,424 square miles and 770,000 people. The capital is Honolulu on Oahu.

The Hawaiian islands were formed as volcanoes built up from the sea bed. Two volcanoes on Hawaii are still active. The islands have a tropical climate. Many white sandy beaches and some unusual black beaches, formed from powdered volcanic rock, fringe the islands.

Hawaiians are descended from the varied peoples who have settled on the islands. These include the early Polynesians, and later Americans, Chinese, Europeans, Filipinos, Japanese and Puerto-Ricans.

Farmers produce sugar cane and pineapples for export, and also flowers. Many people are fishermen. Most of the rest of the people work in tourism or are government or military employees.

The Hawaiian islands were visited in 1778 by Captain James Cook. In about

1795, the islands became a kingdom under a Hawaiian chief. After a revolution in 1893, Hawaii came under the influence of the United States. The United States annexed the islands in 1898.

The United States entered World War II in December, 1941, because Japanese aircraft attacked its base at Pearl Harbor in Hawaii. In the 1960's, tourist facilities were greatly developed.

Many thousands of people flock every year to Honolulu, which has lovely beaches and a great number of fine hotels. A traditional Hawaiian greeting is given to visitors who are greeted by Hawaiian girls and garlanded with flowers.

Hawkes Bay is a province of New Zealand, on the North Island. Its economy is based primarily on its fertile soil and its pasture lands. Farmers keep flocks of sheep for meat and wool and herds of cattle for dairy products. Fruits and vegetables are grown, including grapes for wine. Factories in the cities process the province's agricultural products.

Hawkes Bay is situated on the east coast of the island, on Hawke Bay. The province of Auckland lies to the north and Wellington to the west. The land features are very varied—coastal hills, inland plains and mountains covered with thick vegetation along the western border.

The province has an area of 4,260 square miles, and a population of 125,000. It has two cities, Napier and Hastings, both on the productive Heretaunga Plains. These cities were destroyed by a violent earthquake in 1931, and were later rebuilt.

Europeans first arrived in the region in the 1830's to establish whaling stations and shortly afterwards missionaries came. Later, settlers moved to Hawkes Bay from other parts of New Zealand.

Haydn, Franz Joseph (1732-1809), one of the world's greatest composers, wrote more than 100 symphonies. He also wrote choral and chamber music, as well as a number of operas.

Haydn was fond of England and visited there in 1790 and 1794. He had many successful concerts and received an honorary degree of music from Oxford University. In 1795 he wrote his 104th symphony, which he dedicated to the City of London.

While Haydn was still a young child, his parents and others noticed his love of singing and his unusual ability. He became a choirboy at St. Stephen's Cathedral in Vienna, and a student of music. In 1761 he became a *Kapellmeister* (musical director) in the court of the Esterhazy family. The position gave him money, freedom to compose many kinds of music and the facilities of an orchestra, choir and a staff of opera singers.

In later life, Haydn became a close friend of Wolfgang Mozart. They learned much from each other. After the Esterhazys disbanded their orchestra in 1790, Haydn made two long visits to England. He spent his last years in Vienna.

Haydn gave the *symphony, piano sonata* and *string quartet* their classical forms. His work strongly influenced many later composers.

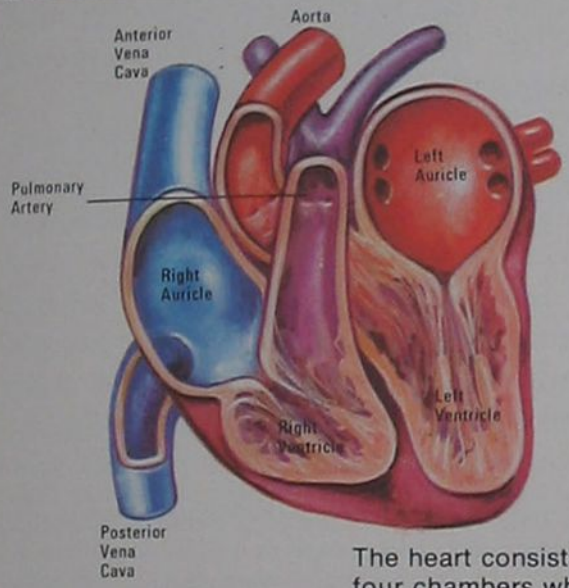
Heart This is the pump that forces the blood to circulate. It goes on working day and night to send blood on its journey through the blood vessels of the body. In man, it pumps 10 pints of blood every minute. In other words, it pumps more than half a million gallons a year.

The hearts of men and other mammals consist of four chambers. These form two separate pumps. The two chambers on the left-hand side of a person's heart pump blood through the various organs and tissues of his body. The blood then returns to the heart—to the right-hand side. This then pumps the blood through the lungs where it picks up fresh oxygen, and back again to the left-hand side of the heart. The blood is then ready to start its journey all over again.

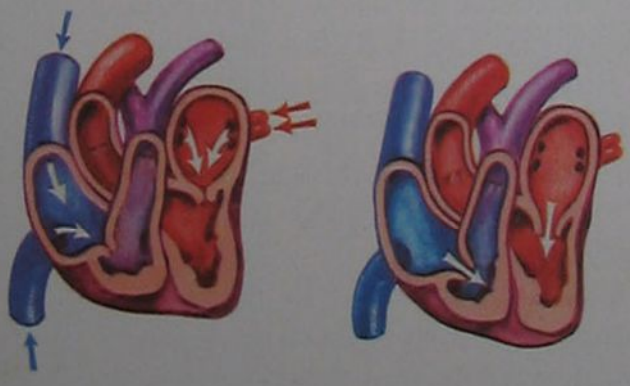
The top two chambers of the heart are

called the *auricles*, the bottom ones the *ventricles*. When the muscular walls of the heart relax, blood enters the auricles, from the lungs or from the body. Then the heart-beat begins. The auricles contract and force blood into the ventricles. Then the ventricles contract strongly, pumping the blood on its way.

Birds also have four-chambered hearts, but the hearts of fishes, amphibians and reptiles are simpler.



The heart consists of four chambers which have walls of special muscle. This muscular pump forces blood round the system. The arteries carry blood away from the heart. Blood flows back to the heart through the veins. The double flow of blood through the heart (see above and left) takes place through the auricles (top chambers) and ventricles (bottom chambers).



Heat If you put a pan on a fire or a stove, it soon gets hot. It does not look any different, but something has obviously happened to it. If you could see the molecules, the small particles that make up the pan, you would find that they were moving about more vigorously than when the pan was cold (see Molecule). In this way, you would see that heat is a form of energy, and that it takes the form of molecular motion.

We get most of our heat from the Sun, and there is also heat deep inside the Earth, which comes to the surface in volcanoes and hot springs. Men produce heat by burning fuels such as coal or oil. These fuels contain carbon, which combines with oxygen from the air to produce heat when the fuels are burned. Nuclear reactions also produce heat.

The hotness or coldness of things is called their *temperature*. Instruments called *thermometers* measure temperature (see Thermometer). People measure temperature in units called *degrees*: the more degrees, the higher the temperature. For most scientific purposes the temperature at which water turns to ice is called 0 degrees, and the normal temperature at which water boils is 100 degrees. This is the *Centigrade* scale, from two Latin words meaning a *hundred steps*. It is sometimes called the Celsius scale, after its inventor, Anders Celsius, a Swedish scientist.

Some people use another scale, called the Fahrenheit scale, after its inventor, Daniel Fahrenheit. On this scale water freezes at 32 degrees and normally boils at 212 degrees. Fahrenheit thought that he had found the lowest possible temperature, which he called 0 degrees in his scale. Scientists now believe the lowest temperature, which they call Absolute Zero, is minus 460 degrees on the Fahrenheit scale, or about minus 273 degrees on the Centigrade scale.

Heat can travel in three ways: by *radiation*, by *convection*, and by *conduction*. In radiation, heat travels through space,

as it does from the Sun or a fire. In convection, it travels through moving water —as in a central heating system—or moving air, as from a convector heater. In conduction, heat travels through a substance, as it does along a metal rod when one end of it is held in a flame.

Heat travels very slowly through some substances. These substances are said to be *insulators*. Examples of good insulators include wood, bricks and paper.

Many things change when they are heated. Metals *expand*, that is, they grow slightly larger in size. Railway engineers used to leave gaps between the ends of rails, so that if they expanded in the heat of the Sun they did not buckle but had room to 'grow'. Air also expands when it is heated. Early fliers used hot air to fill their balloons, because the expanded hot air in the balloon was less dense than the cold air around it. Water expands when heated. For example, a full kettle overflows when the water in it gets hot. Very hot water becomes steam, which expands very greatly.

Many solids turn to liquid when they are heated—for example, ice turns to water, and metals finally melt. When heat is applied to a solid, it can either go to raising its temperature or to melting it. Heat which raises the temperature does so by making the solid molecules *vibrate*, or move faster. This kind of energy is called *kinetic* energy, which means energy of motion. If heat is continually supplied to a solid, its molecules vibrate more and more until eventually they 'fall apart' and the solid melts. In a similar way, heated liquid eventually boils and becomes a gas or vapour. Heat which changes the state of a substance from a solid to a liquid, or from a liquid to a gas, is called *latent heat*.

Man uses heat for many purposes. The most important is for keeping himself warm. He also uses it to change the nature of things, for example in cooking food and firing pottery.

Talking points

*Heat travels in three ways: radiation, conduction and convection. When your mother cooks your dinner, what way does the heat from the cooker make the food hot?

*Explain, in your own words what happens to an object when it gets hot. Why does the state of matter change when it is heated beyond a certain temperature?

*To survive, the human body has to be kept warm. Trace the developments of the methods by which Man has done this.

Articles to read

Energy; Fire; Fuels; Light; Molecule; Power.

Hector was a famous warrior of ancient Greek mythology, the son of the Trojan king, Priam, and his wife Hecuba. Hector bravely defended the city of Troy against the attacks of the Greeks during the Trojan War. The story of the war appears in Homer's great epic, the *Iliad*.

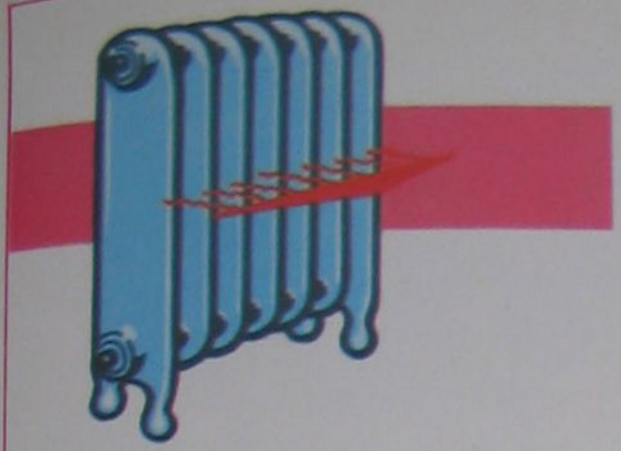
During one of the battles of the war, Hector killed a Greek named Patroclus. To avenge this death, Achilles, another Greek warrior, later killed Hector and dragged his body around the city behind his chariot. Priam begged Achilles for his son's body and finally paid for it with gold. He gave Hector a magnificent funeral.

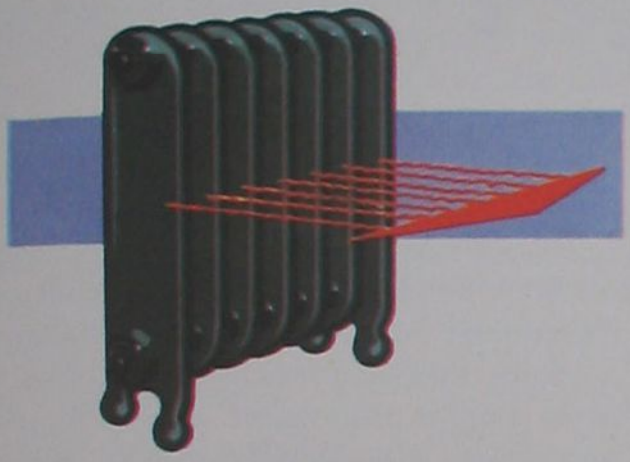
A hedgehog rolls itself into a ball when threatened and relies on its spines to protect it from attack.

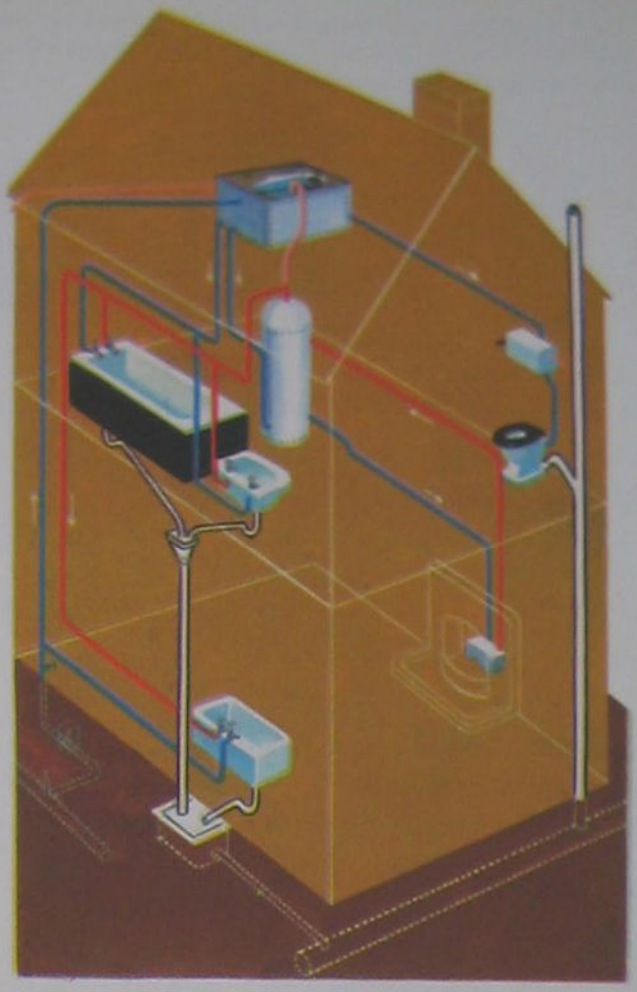
Hedgehog The hedgehog is a small animal whose back is covered in sharp spines, like a porcupine's (see Porcupine).

But hedgehogs are not related to porcupines, and their spines are closer and shorter. When a hedgehog is in danger, it rolls itself up into a ball, so that its spines protect it.

Hedgehogs live in Africa, Asia and Europe. A fully grown hedgehog is only about nine inches long. It has a pointed snout and a small mouth. It is classed



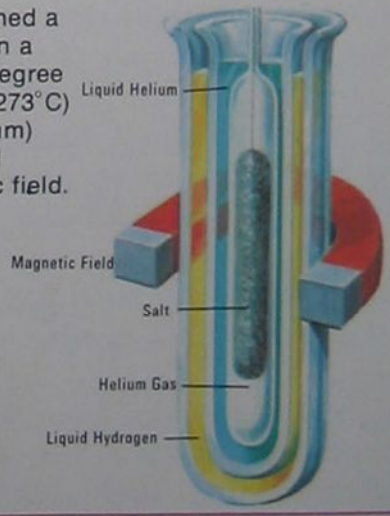




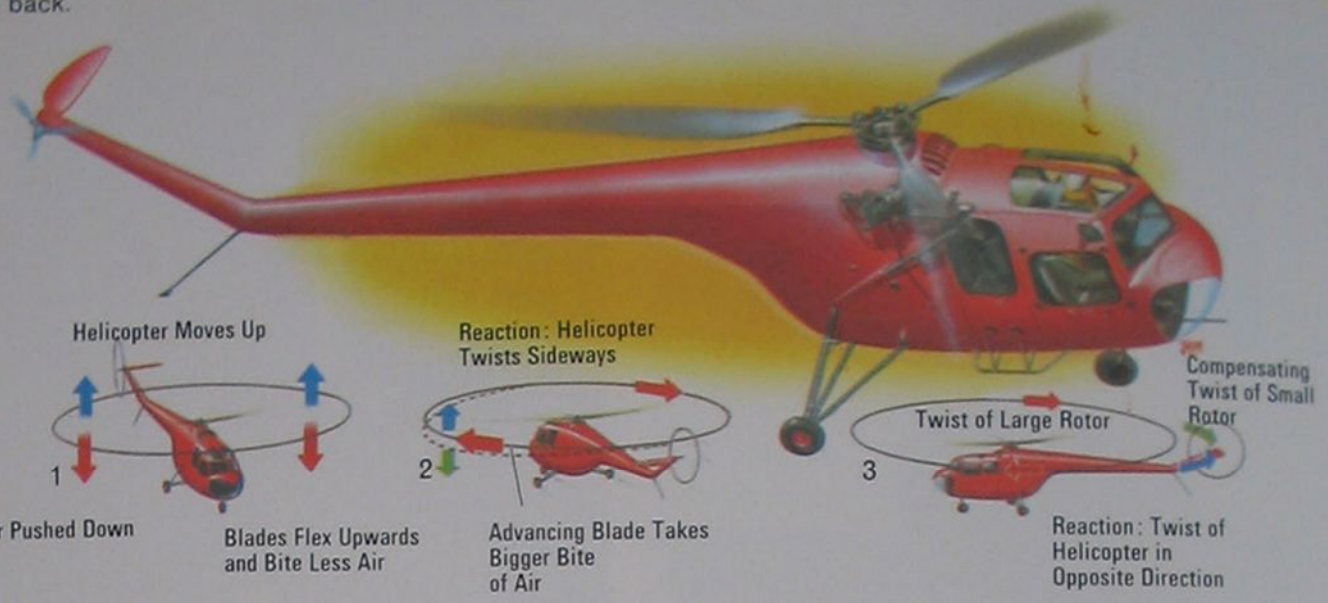
Heat travels by three methods: radiation, convection, and conduction. Above left: As a body, like a radiator, absorbs radiation it collects energy. A body which is steadily accumulating energy soon becomes hot, and this cannot continue indefinitely. So the body gets rid of its energy by radiating it. Black bodies absorb and therefore radiate, more heat than white bodies. Above right: A water-heating system. Cool water is fed to the bottom of a boiler and rises by convection as it is heated. From the top of the boiler it circulates, gradually losing its heat, and returns to the boiler for the cycle to be repeated. Right: Diagram showing how heat travels by conduction through an object. As one end of the object is heated the molecules vibrate strongly and the vibration is gradually transmitted from molecule to molecule throughout the object.

All materials expand when heated, though the amount of expansion varies a great deal. Generally, gases expand more than liquids and liquids expand more than solids. The rapid expansion of an exploding mixture of gases in the cylinders of an internal combustion engine is used to push a piston.

Scientists have reached a temperature of within a few millionths of a degree of Absolute Zero (−273°C) by cooling a salt (alum) surrounded by liquid helium in a magnetic field.



The helicopter (see below) moves forwards by increasing the pitch of the main rotor blades as they sweep around the back.



The three diagrams above illustrate the principles of a helicopter's movement thus: (1) A helicopter hovers or moves vertically by pushing air down with its rotor. (2) The rotor blades flex upwards as they move forwards. (3) The twist of the large rotor is compensated by a small rotor near the tail.

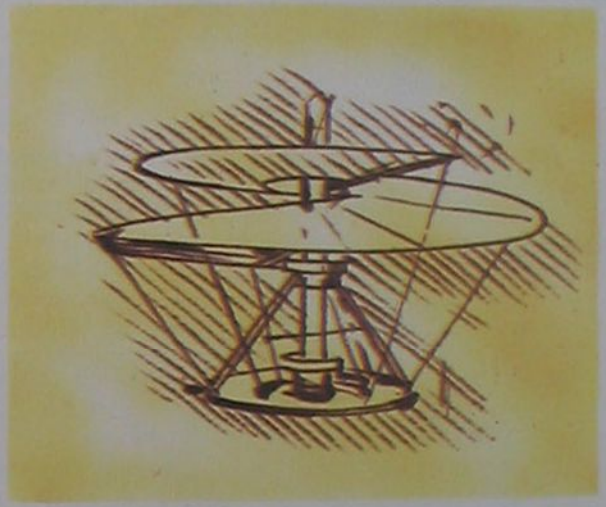
as an *insectivore* (insect-eater), but it will also eat other small animals, such as worms and birds' eggs. In cool regions, hedgehogs hibernate in winter (see Hibernation).

Helicopter The helicopter is our most versatile flying machine. It can fly straight up or down, hover like a fly, and go forwards, backward, or sideways. It therefore needs no prepared runway and can operate from a flat roof or a jungle clearing with equal ease.

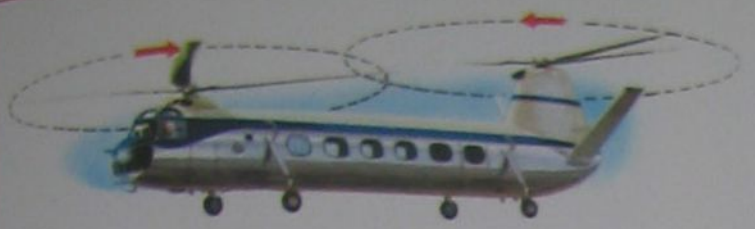
Helicopters are nowhere near as fast as normal aircraft. But their manoeuvrability has made them invaluable for inter-city transport, sea rescue, spraying crops, and hundreds of other uses.

The helicopter has often been called the 'flying windmill' because of the rotating blades, or *rotor*, on top of its body. These serve as both the propellers and wings of a fixed-wing aircraft. They provide the 'thrust' to drive the helicopter along and the 'lift' to raise it off the ground. (See Aircraft.)

The rotor blades have the same aerofoil shape as wings and propellers. But they differ in that their *pitch*, or angle at



The great artist Leonardo da Vinci designed a helicopter (top), or a machine planned to fly vertically, but it never flew.
Above: A design by Sikorsky for a helicopter made in 1910. Here the problem was one of balance which was not solved until 1938.



An alternative design for a larger helicopter (see left) capable of carrying a greater number of passengers. This is the Bristol 173, a helicopter balanced by having two large rotors rotating in opposite directions.

which they slice through the air, can be altered. In this way, the helicopter can be made to fly in any direction.

Another, upright rotor at the tail prevents the body swinging round when the main rotor turns. The pitch of the tail rotor can be altered, too, to turn the helicopter while hovering.

The helicopter controls are relatively simple. The *collective pitch stick* controls vertical movement, and the *cyclic pitch stick* controls horizontal movement. Foot pedals control the tail-rotor pitch.

The idea of a helicopter is not new. Leonardo da Vinci sketched a simple one in about 1500. But the first man-carrying craft were not built until the early 1900's. In 1907, Paul Cornu and Louis Bréguet in France built helicopters which rose slightly in the air.

In the 1920's, Juan de la Cierva developed his autogiro, which had a front propeller like a normal aircraft but a freely rotating rotor instead of a wing.

The German aircraft company Focke built a practical helicopter with twin rotors in 1938. A year later, Igor Sikorsky demonstrated his single-rotor craft in the United States. This craft was the forerunner of the modern helicopter.

Helium After hydrogen, helium is the lightest of all the chemical elements. It is the gas which is normally used to inflate balloons. It is much safer for that purpose than hydrogen because it does not burn or explode like hydrogen does. In fact helium does not easily react with any other substance. It is one of the so-called *inert gases*, which also include neon, argon, krypton, xenon and radon.

Another interesting use for helium is in breathing mixtures for deep-sea divers. Breathing normal air (oxygen and nitrogen) at great depths may give rise to a dangerous condition called nitrogen poisoning. The danger is lessened if helium is substituted for nitrogen.

In industry, helium is used for fireproofing electrical equipment and for shielding some metals during welding.

There is a tiny amount of helium in the Earth's atmosphere. In the United States, helium is found in natural gases.

Henry was the name of eight English kings. One was a Norman, two were Plantagenets, three were of the House of Lancaster, and two were Tudors.

Henry I (1068-1135), the youngest son of William the Conqueror, was born at Selby in Yorkshire. When his brother William II was killed while hunting in the New Forest in 1100, Henry immediately made himself king.

Henry was a strong and able king, and did much to establish peace between the Saxons and their Norman overlords. He put down crime ruthlessly and laid the foundations of an effective system of justice. His marriage to Matilda, the daughter of Malcolm III, king of Scotland, was popular because she was descended from earlier English kings. Their only son, William, was drowned when the *White Ship* sank in 1120, and Henry left the throne to his daughter Matilda, or Maud, the widow of the Emperor Henry V. The barons promised to support her, but when Henry died the crown was taken by his nephew Stephen.

Henry II (1133-1189) obtained the

throne through his mother Matilda, the daughter of Henry I. He became king on the death of Stephen in 1154. He was lord not only of England but also of Wales and Ireland, and the French territories of Normandy, Anjou, Maine, Touraine, Poitou, Aquitaine, Gascony and Brittany. He inherited the French territories through his father, Geoffrey of Anjou.

Henry found his English kingdom in disorder. Few of the barons acknowledged the king's authority and the country was swarming with private armies. Henry destroyed the barons' castles and broke up their bands of supporters. From London Henry's servants reached out to all parts of the country. He sought to make the 'king's justice' available to everybody.

By trying to subject the Church to the civil law, Henry came into conflict with Thomas à Becket, Archbishop of Canterbury. The quarrel resulted in Becket's murder in Canterbury Cathedral. The King had to abandon his demands and do penance at Becket's tomb.

Henry III (1207-1272) was the eldest son of King John and a grandson of Henry II. He ruled for 56 years – one of the longest reigns of any English sovereign. He became king at the age of nine and, until he came of age in 1227, the country was ruled in his name by William Marshal, Earl of Pembroke, and then by Hubert de Burgh.

Henry was a patron of learning, gave large sums of money to charity, and was very religious. But he was a weak and indecisive ruler, and was greatly influenced by his favourites among his courtiers.

During Henry's reign, the King's Great Council was made larger to include representatives of the *shires* (counties). People began to call it the *Parliament*. In 1258, Henry came into dispute with the Council, and eventually civil war broke out between his supporters and a powerful group of barons led by the King's brother-in-law, Simon de Montfort. Henry was defeated and taken prisoner at Lewes in 1264. However, in the following year, Henry's son, Edward, defeated de Montfort at Evesham. For the rest of Henry's reign, the real ruler was Edward, who in time succeeded his father as Edward I.

Henry V was a great warrior and William Shakespeare saw him as a great patriotic orator as well:
'Once more unto the breach, dear friends, once more;
Or close the wall up with our English dead! . . .
. . . Follow your spirit; and, upon this charge
Cry "God for Harry! England and Saint George!"'

Henry IV (1367-1413) was the son of John of Gaunt and the grandson of Edward III. When he was young, he was known as Henry of Bolingbroke. In 1398 he quarrelled with his cousin King Richard II and was banished. In the following year, he returned to England, raised an army and seized the throne. Parliament acknowledged Henry's claim, but in consequence he was from then on dependent on the goodwill of parliament.

Henry was beset by troubles on all sides. The Welsh, led by Owen Glendower, rebelled, and the Scots invaded England. The Scots were stopped by the Percys, the earls of Northumberland, but the Percys later joined with Glendower against the King. However, Henry managed to defeat the rebels at the Battle of Shrewsbury in 1403.

Henry V (1387-1422) was the son of Henry IV, and succeeded his father as king in 1413. His great aim was to recover the French kingdom that he believed to be rightly his. He invaded France in 1415, and at the Battle of Agincourt on October 25 defeated a much larger French army. He captured Rouen in 1419, and the French King Charles VI agreed in the Treaty of Troyes that Henry should succeed him on the throne of France. Henry married Charles's daughter Catherine of Valois. He never became king of France, because he died before Charles.

Henry VI (1421-1471), the son of Henry V and Catherine of Valois, was only nine months old when he became king of England. Two months later, on the death of his grandfather Charles VI, he also

A portrait of Henry VIII, copied from one by Holbein. Henry is usually remembered as the king who had six wives, but his Reformation of the Church and the dissolution of the monasteries were among the most far-reaching actions ever taken by an English monarch.

became king of France. His uncle, the Duke of Gloucester, acted as his regent in England, and another uncle, the Duke of Bedford, as regent in France.

In France, Henry's claim to the throne was disputed. Charles VI's son had proclaimed himself king as Charles VII and bitter fighting took place between the supporters of the rival monarchs. The English, defeated at Orleans and other places by Joan of Arc, later captured her and burned her at Rouen. Henry VI was crowned king of France in Paris in 1431.

But from then on his supporters gradually lost ground and when, in 1453, the Hundred Years' War with France finally came to an end, only Calais remained in English hands.

In 1453, Henry became insane, and the barons made his cousin, Richard, Duke of York, Protector of England to act in the King's place. Richard had a strong claim to the throne, and when Henry recovered his sanity in 1455, Richard was reluctant to give up power. Some of the nobles, the Yorkists, supported Richard. Others, the Lancastrians, took Henry's side, and a struggle—called 'the Wars of the Roses'—began. At the Battle of Northampton in 1460, the Yorkists defeated the King's army and took Henry prisoner. Richard was killed at the Battle of Wakefield, also in 1460, but his son Edward continued the struggle. He defeated the Lancastrians at Tewkesbury in 1471, and seized the throne as Edward IV. Henry was imprisoned in the Tower of London, and put to death.

Henry VII (1457-1509) claimed the throne as a representative of the House of Lancaster, because his mother Margaret Beaufort was a descendant of John of Gaunt. Henry's father, Edmund Tudor, Earl of Richmond, was a Welshman, whose father had married the widow of Henry V. In 1485, Henry overthrew and killed Richard III at the Battle of Bosworth Field in Leicestershire, and was recognized by Parliament as the rightful king. He made his position stronger by marrying Elizabeth of York, daughter of Edward IV.

During his long reign, Henry consolidated the power of the throne with great skill and force. He lessened the threat from the nobles by forbidding them to keep the retainers who had constituted their private armies. He encouraged trade and avoided involvement in foreign wars. His commercial policies gave power and influence to the middle classes in the cities, whose growing prestige balanced that of the nobles. Henry gave his daughter in marriage to King James IV of Scotland. This marriage eventually led to the union of the two kingdoms.

Henry VIII (1491-1547) was the son of Henry VII and succeeded his father as king in 1509. He was bold and determined by nature but he was also pleasure loving.

In the early part of his reign he left affairs of state largely in the hands of his chief minister, Cardinal Wolsey. In 1511 he joined the forces of the Holy League in the war against France. In 1514 Henry switched his support to Louis XII of France and also gave his sister Mary to Louis in marriage. Later he again threw in his lot with France's enemies.

Henry was interested in many branches of knowledge. In 1521 he wrote a book in which he disputed the views of Martin Luther. For this, he was given the title 'Defender of the Faith' by the Pope.

Henry had been granted a dispensation by the Pope to marry Catherine of Aragon, the widow of his older brother Arthur. He and Catherine had five children, of whom only one daughter, Mary, survived.

In 1526, Henry fell in love with a lady at court, Anne Boleyn. He tried to have his marriage with Catherine annulled by the Pope. When Wolsey was unsuccessful in persuading the Pope to do so, Henry dismissed him. Wolsey was later sent for trial for high treason, but died before the trial began.

Henry married Anne Boleyn in 1533 after the new Archbishop of Canterbury, Thomas Cranmer, declared his first marriage void. He was by now determined to break with the Pope. With the agreement of Parliament, and aided by his new chief adviser Thomas Cromwell, he compelled the clergy to acknowledge him as supreme head of the Church of England. The Pope was declared to have no authority in the kingdom. The reform of the Church was continued by dissolving the monasteries. This provided money for Henry, and by distributing the lands and buildings of the monasteries he gained a new class of supporters.

In 1536 Anne Boleyn was executed, after being charged with crimes against the King, and Henry married Jane Seymour. She died in giving birth to the child who later became Edward VI. Henry then, in 1540, married a German princess, Anne of Cleves, because he was anxious to have the support of the Lutherans in Germany. But he disliked her and her friends and divorced her within six months. Thomas Cromwell, who had arranged the marriage, was discarded and put to death. Henry then married Catherine Howard, but within two years she was put to death on the same grounds as Anne Boleyn. Shortly afterwards, the King married Catherine Parr, who survived him. He died at Richmond four years after his marriage, leaving enormous wealth.

Towards the end of his life Henry VIII became grotesquely fat and slothful. In his youth, however, he was a well-built and powerful man. He was an excellent sportsman and records show that he hardly ever lost a game of tennis. It is possible, of course, that his opponents took good care not to beat the king! Henry decided to marry Anne of Cleves without having met her, although he had seen a portrait of her. When she arrived in England, the king saw that the portrait had made her much more attractive than she actually was. He remarked that he had been brought a 'Flanders mare'.

Each of Henry's surviving children succeeded to the throne. They were Edward VI, Mary I, and Elizabeth I, daughter of Anne Boleyn. During Henry's reign, Wales was officially incorporated into England, and the English king became king of Ireland, too.

Henry the Navigator (1394-1460) was a Portuguese prince, the son of King John of Portugal. He organized expeditions that explored the western coast of Africa. His explorers went as far south as present-day Senegal, but after his death later navigators, Bartholomew Diaz and Vasco da Gama, continued the routes around the southern tip of Africa and on to India.

Henry never went on any voyages himself, but he outfitted scores of ships and picked their captains. He gathered together a team of geographers to make maps, and encouraged the development of navigational equipment. His explorers reached Madeira in 1420, the Cape Verde islands in 1445 and Senegal in 1460.

Henry built a base for his explorations at Sagres, at the extreme south-westerly

point of Portugal. It included an observatory and a school of geography.

Heraldry In the days when men wore complete suits of armour in battle, it was often very difficult to tell friend from foe, let alone recognize individuals. So knights took to painting personal designs or emblems on their shields, or on *surcoats* which they wore over their armour. These designs are called *coats of arms*, and people could inherit them like titles. Many families still have coats of arms, and use them as personal emblems. Towns and other bodies also have coats of arms.

The study of coats of arms is called *armory* or *heraldry*, and the people who control and design coats of arms are called *heralds*.

The language of heraldry is a technical one based on old French. Heralds call colours *tinctures*, and give them the following names and classifications: Metals—*or* (gold), *argent* (silver); colours—*azure* (blue), *gules* (red), *vert* (green), *sable* (black), *purpure* (purple). There are also some stylized designs representing furs—*ermine*, *ermines*, *erminois*, *pean* and *vair*.

The designs on shields are called *charges*. They range from bars, crosses, and animals to ships and musical instruments. The coats of arms with the simplest charges are generally the oldest. Sometimes two or more charges are combined on one shield. This usually indicates that members of two important families have married. In the royal coat of arms of Britain, the three leopards (which appear twice) represent England, the *rampant* (upright) lion Scotland, and the harp Ireland.

A full coat of arms is called an *achievement* of arms, and includes the following: the *shield*, bearing the charge; the *helmet*, showing the rank of the bearer of the coat of arms; the *crest*, often an animal or bird, which appears on the helmet, and *supporters*, figures either

Above: The shield can be divided up in any one of a number of conventional ways. These are some of the most common.

Above: Stylized animals and objects are often included in heraldic designs.

Below: Some examples of coats of arms.

side of the shield which appear to hold it up. Also indicating rank is the *coronet*, which sits on the helmet, or the *torse*, a band of twisted cloth used by people not entitled to a coronet. The coat of arms also has a motto, which is usually in Latin.

Herbivore is the name given to any animal that eats mainly plant food, rather than meat. The two main groups of herbivorous mammals are the *rodents*—the gnawing animals such as mice and squirrels—and the *ungulates* or hoofed mammals. These hoofed mammals include the largest land animals—elephants, rhinos and hippos—as well as horses and antelopes. The group also includes farm animals such as sheep, goats and cattle. These are *ruminants*—that is, they have special stomachs divided into four sections. Food is swallowed into the first section, known as the *rumen*, where bacteria help to break down the plant tissues. The food is then passed back to the mouth and chewed again—this is called 'chewing the cud'—before it goes to the other parts of the stomach.

Many herbs are in use today for medicinal purposes. Many are also used in cooking to flavour dishes. From left to right, below: Thyme, marjoram, tarragon, sage and mint.

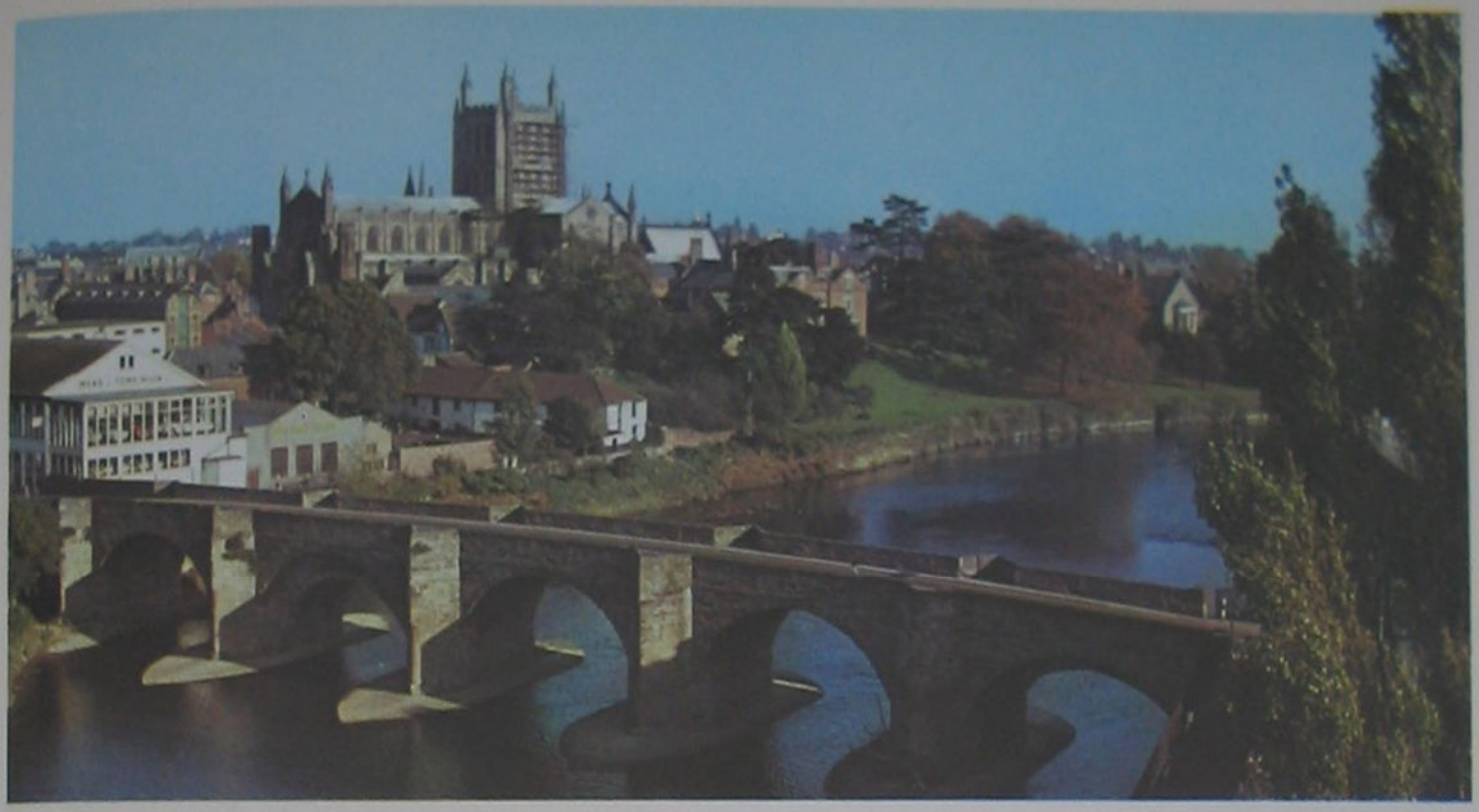
Herbs mean one thing to a botanist, another to a housewife, cook, or gardener, and something else again to a pharmacologist or chemist. To botanists, a herb is a plant that has a soft, non-woody stem. To cooks, herbs are plants that have highly scented leaves which are used to add flavour to foods. Herbs widely used in the kitchen include, mint, parsley, sage and thyme. Culinary herbs are at their best when full-grown but not yet in flower. It is always best to pick them early in the morning before they lose their fragrance in the hot sun.

Medicinal herbs are those that contain drugs useful in combating diseases in man. Pharmacologists usually supply dispensing chemists with synthetic drugs today, but medicinal herbs are still preferred by some people.

Heredity is the passing on of bodily characteristics from parents to their offspring. Thus a child may inherit blond curly hair, blue eyes, a tall slim build, or a long straight nose. But it can only inherit the kind of characteristics its parents were born with. If a parent was born with a deformity—only four fingers on each hand, for example—then its children may be similarly deformed. But if the finger was lost in an accident, this cannot be inherited.

Basically, what a child inherits from its parents is a set of *genes*. These are chemical 'instructions' for building the new person. They are carried on the *chromosomes*, tiny thread-like structures in the nucleus of each cell (see Cell; Chromosomes). In sexual reproduction, a sperm cell from the male unites with an egg cell from the female. When this happens, the two sets of genes from the parents unite to form the single set of instructions for the offspring.

Agricultural scientists use heredity to develop new and improved *strains* (varieties) of crops and animals. For example, by crossbreeding two types of sheep—one good for wool, the other good for meat—they have produced sheep combining the best qualities of both—good wool and good meat.



Hereford cathedral was started in 1079 and completed in 1535. It is composed of many different styles of architecture. The town grew up around the Wye bridge.

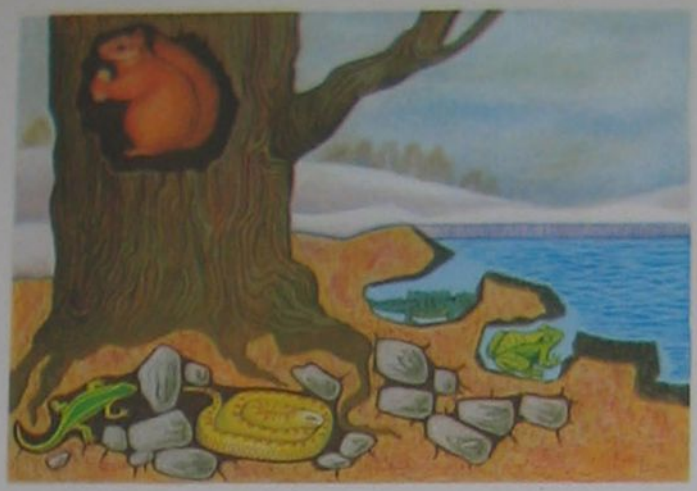
Herefordshire, an English county bordering on Wales, is almost entirely agricultural. Its wide, rich fields and its apple and pear orchards lie between the beautiful Malvern Hills of the east and the Black Mountains and the hills of the Radnor Forest in the west. The River Wye, which flows eastwards across the county, is famous for the scenery of its valley and the valleys of its tributaries. Hereford, on the Wye, is the county town and has a celebrated cathedral. Herefordshire's area in 845 square miles; it has a population of 138,500.

Farmers grow wheat and oats, and raise sheep and cattle. The hardy cattle called *Herefords* were first bred in the county, and are now to be found in several parts of the world, including North America and the Soviet Union. In southern Herefordshire, there are many hopfields. There are orchards in most parts of the county, which has long been known for its cider.

Hertfordshire, one of the Home Counties of England, is chiefly agricultural despite the fact that it lies just north of London. Its area is 630 square miles. In the west there are spurs of the Chiltern Hills, and altogether some two-thirds of the county lies on the gentle Chiltern slopes. The principal rivers are the Lea, which rises in Bedfordshire, and the Colne. The population is 922,000.

Hertford, in the east of the county, is the county town. St. Albans and Watford are among the more important of the older towns, but Hertfordshire also has the well-known 'garden cities' of Welwyn Garden City and Letchworth, and the 'new towns' of Stevenage, Hemel Hempstead and Hatfield. The garden cities and new towns are communities designed to relieve overcrowding in London.

Hibernation is the period of unconsciousness by which many animals pass the winter, when food is scarce. In the late summer and autumn, the animal eats a lot while food is plentiful, and gets fat. Then, as winter approaches, it finds a hidden and sheltered spot in which to hibernate — a hole in the ground or under a pile of leaves, perhaps. The animal gradually becomes less and less active, until it falls asleep.



Above: A composite picture of animals taking their long winter sleep.

Right: Two hibernating dormice. The dormouse becomes very fat before it goes into hibernation; but it loses a lot of weight during its months of sleep.

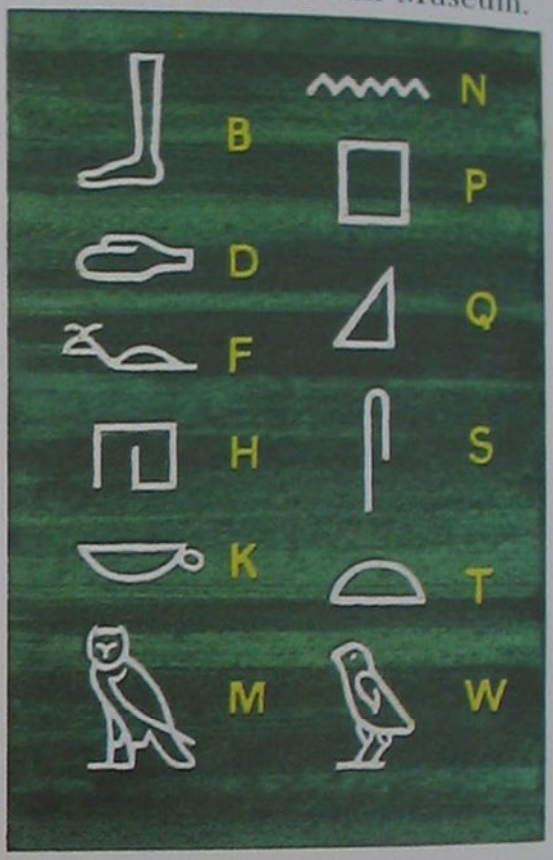
During the long 'sleep', its breathing and heartbeat becomes very slow and its body temperature drops. In this way, the creature needs very little food. The fat in its body supplies what food it does need. Some animals stay like this until spring arrives and there is food again. Others may wake up on the warmer days of winter, eat some of the food they have collected, and then hibernate again.

Animals that hibernate are mainly small ones living in the cooler parts of the world. They include many small mammals, such as dormice, hedgehogs, chipmunks and skunks. Some amphibians and reptiles, such as frogs, toads and tortoises, also hibernate. Hibernating insects include bees and some kinds of butterflies.

Hieroglyphics are pictures used for writing instead of letters. Hieroglyphics are usually the first stage in the development of writing by a people. Each hieroglyphic stands for a word or an idea. In many cases the hieroglyphic is a picture of what it represents.

The best-known hieroglyphics are those used by the ancient Egyptians. They contain many bird-like symbols, and the writing was read in the direction faced by these birds. The Egyptians also used hieroglyphics for syllables. Word hieroglyphics had the same sound as the syllables. In English, for example, this would be the same as using pictures of the *sea* and the *Sun* to write the word *season*.

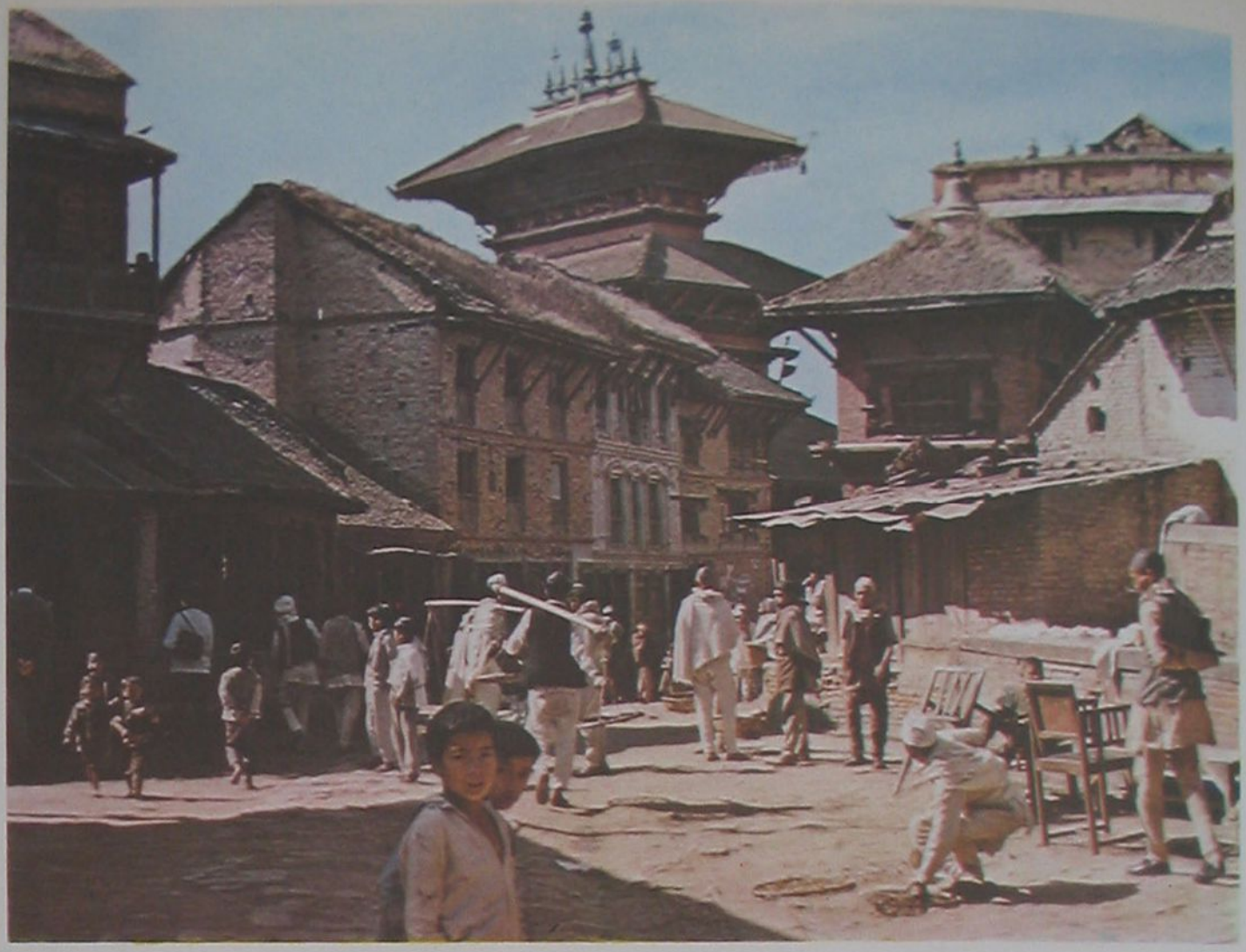
In 1799, a large stone was found in Egypt on which was written an ancient Egyptian decree in hieroglyphics and in Greek. From this stone, called the *Rosetta Stone*, the hieroglyphics were *deciphered* (translated). The Rosetta Stone is now in the British Museum.



Before letters as we know them today men used a form of picture writing known as hieroglyphics. Each character represented a word or idea, and from these symbols our modern alphabet gradually evolved.

Himalayas The Himalayas are the highest range of mountains in the world. They form a gigantic mountain wall to the north of India, running 1,500 miles from the Pamir knot in the west to the borders of China and Assam in the east.

The Himalayas are composed of a series of parallel ranges (usually three) which rise progressively northwards. The highest peaks include Everest, which at 29,028 feet is the highest in the world, Kanchanganga (28,166 feet) and Lhotse



Above: Katmandu is the capital of Nepal, an Indian state in the Himalayas. The vale of Nepal lies around the town, and is a fertile rice, sugar and fruit growing area which has given its name to the whole country. It is situated in a valley between the Mahabharat and Lesser Himalaya mountain ranges.

(27,923 feet). Many great rivers such as the Indus, Ganges, Brahmaputra and Sutlej have their sources in these mountains and rush through deep gorges down to the plains.

To the north of the Himalayas lies the lofty, desolate tableland of Tibet about 470,000 square miles in area. Tibetans are of Mongol origin and their main occupation is the rearing of sheep, yaks, long-horned cattle and horses, as well as the transit of goods across the mountains.

Nepal is an Indian state in the Himalayan foothills. The population make a poor living as small farmers on the mountain slopes. The people, who are known as Gurkhas, are tough fighting men and have won acclaim as some of the best troops in both the Indian and the British armies.

Hinduism is the religion of most Indians. Its teachings comprise a way of life and a social order, a system of laws, and poetry and philosophy. Some Hindus believe in one god, some in many. Others are mystics and have no belief in a personal deity. The beginnings of Hinduism are not clear, but it has absorbed many other beliefs over 3,500 years, and from it have developed other faiths, such as Buddhism and Jainism.

The central theme of Hinduism is that true reality is oneness—all things in the world are united and the idea of separate selves is false. Other religions are accepted because they are different ways of searching for the same truth. Brahman is the supreme spirit, the sole reality. All Hindu deities are aspects of Brahman. The three main deities are

Brahma, the creator of the universe, Siva, the destroyer, and Vishnu, the preserver.

Brahman is the source of *atman*, the soul which flows through all forms of life, whether animal or vegetable. It is eternal, never dying but changing form in continual rebirths according to the law of *karma*, which is a system of rewards and punishments. A man who has lived a wicked life may be reborn as an unpleasant animal or as a worm. But the reward for a virtuous life is a noble birth. The final goal is union with Brahman. By practising *yoga* and living a life of self-discipline and concentration, man can approach this ideal.

Hindu society is divided into ranks or *castes*. The four main ones are *brahmans* (priests), *kshatriyas* (nobles and warriors), *vaisyas* (merchants and farmers) and *sudras* (labourers). Those without caste are *pariahs* (untouchables). They live in great misery and poverty, although the practice of *untouchability* is illegal in India. Caste cannot be changed except through rebirth.

Of the countless Hindu scriptures, the four *Vedas* are a collection of hymns. The *Brahmanas* are texts written by the priests. The *Upanishads* are philosophical and theological treatises.

Below: A representation of one of the many Hindu deities, all of which are regarded as different aspects of Brahma, the supreme creator of the entire universe, worshipped under many different forms.

Hippocrates (460?-377? B.C.), a Greek physician from the island of Cos, is called the Father of Medicine because of his scientific approach to the cure of disease. His treatments included careful diet, a cautious use of drugs, and occasionally surgery. He wrote many papers on medical topics. Hippocrates is thought to have set down the oath of moral or right behaviour for the medical profession, which became known as the Hippocratic Oath. In some countries, medical students still take this oath today when they become doctors.

The name of the hippopotamus is derived from the ancient Greek, meaning 'river horse'. It can move with great speed at times despite its stocky appearance and great bulk, but is more at home in the water.

Hippopotamus This is a huge animal living in the rivers and swamps of tropical Africa. It stands 5 feet high and is up to 14 feet long. It weighs up to 4 tons, and is second in size among land animals only to the elephants. The rarer pygmy hippopotamus is much smaller, weighing only a quarter of a ton.

Hippopotamuses have barrel-shaped bodies and thick legs. They can run quite fast, but they are far more at home in water, which supports much of their weight. Hippopotamuses live in herds of 20 to 30 animals, and may stay for hours in the water with only their eyes and nostrils above the surface. They have huge mouths, but eat only plant food.

History is the story of mankind's past. There can be a history of anything men and women have done or thought. Reli-

gion has a history, so has scientific knowledge, building houses and fighting wars. A great many of the entries in this or any other encyclopedia will tell you about the history, the past, of the subject they deal with. Words have a history: 'history' itself comes from the Latin 'historia' and the Greek 'historikos', which meant at first any narrative or story, then a story of true past events as compared with a story which was made up (fiction).

Most human societies came to choose a particular event from which they date all later happenings. The Romans began their dating with the year in which they believed, wrongly, that Rome had been founded. We call it 753 B.C., that is before Christ. Christians date everything from the supposed birth of Christ, though he was probably born four years earlier. Because Christian countries came to rule most of the world in the last two or three centuries, the Christian method of dating is used almost everywhere in the world today. B.C. is Before Christ and A.D. (Anno Domini, in the year of Our Lord) is after Christ.

The Muslims dated everything as A.H., after the Hegira, or flight of Mohammed from Mecca to Medina (A.D. 622 to Christians). Because the Muslim year is shorter than the Christian year 1388 A.H. was the year which ran from March 31, 1968 to March 19, 1969. The Jewish Calendar begins at the creation, which Jewish legend puts in the year Christians call 3760 B.C.

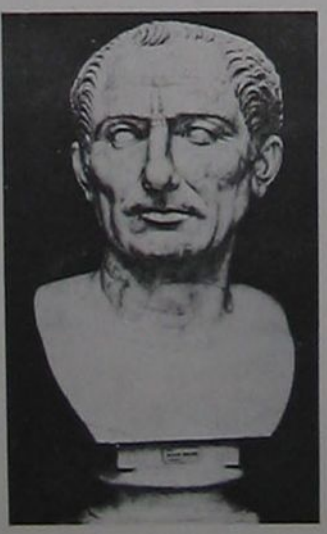
With ways of dating happenings people began to keep chronicles of events. Chronicles were kept by Christian monks in the Middle Ages. Chronicles are more than mere lists, for they date the events they record by a common dating and they comment on them. Matthew Paris, the great chronicler of St. Albans Abbey, for example, writes: "Anno Domini 1251, the thirty-fifth year of the reign of King Henry the Third, because his brother Ailmar was nominated to the episcopal see (post of bishop) which was vacant, he (the king)

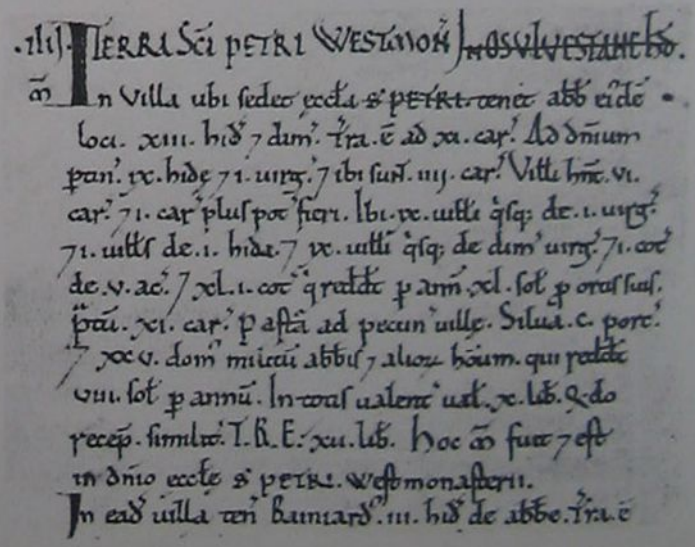
THE ILLUSTRATED LONDON NEWS

SATURDAY, NOVEMBER 21, 1868.

Public records and official documents compiled for purely practical purposes can yield valuable material for the writing and interpretation of history. The Domesday Book (an extract from which is reproduced below) is still being constantly researched in order to understand the facts of a greater part of the economic and agricultural life of England after the Norman Conquest. The book was a comprehensive survey of the resources of the country, made to enable the new conquerors to control and exploit their newly acquired realm to the full. Such seemingly unlikely sources as prayer books and psalters can also produce information and illustrations of value. Right: A full page miniature representing the Martyrdom of St. Thomas Becket, from a Latin Psalter of about AD 1200.

Newspapers, books, and periodicals of all kinds like the London News (above) are an invaluable source of material for historians. They record the facts and opinions of their times and enable researchers to judge the feeling of an age in a unique and lively way. Often the great figures of every age write their own accounts of events in which they were prominent. Julius Caesar was one great general who left his own account of his wars.

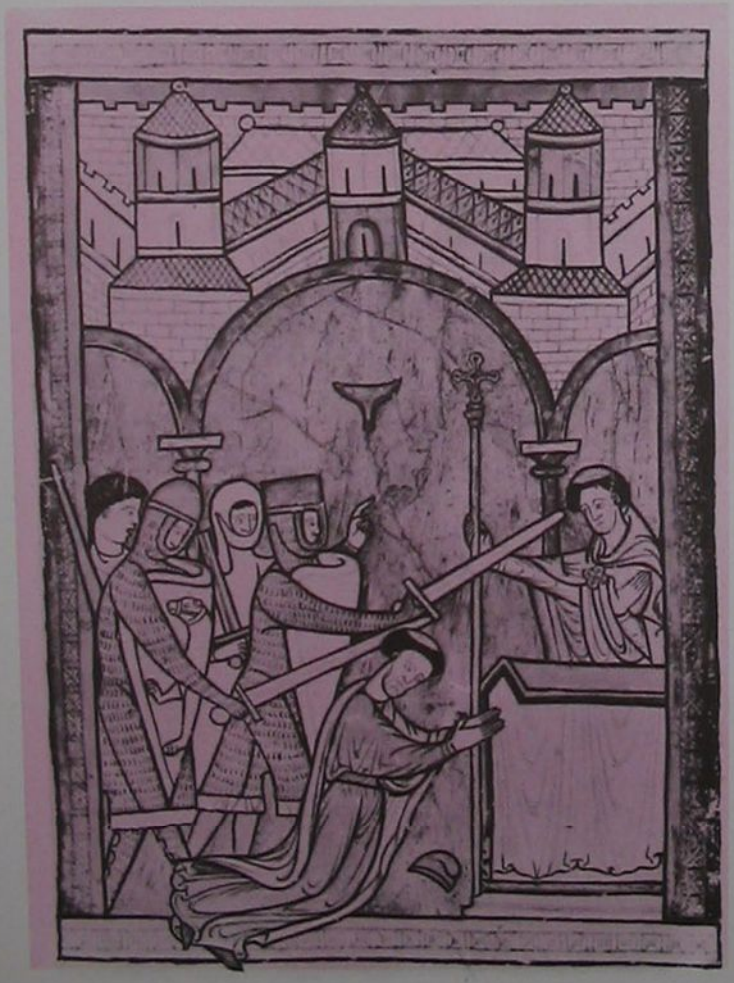



TERRA Scī PETRI WESTMON

restrained his rapacious hands from plundering the property of the bishopric, as was his usual custom". This tells us that, in the opinion of Matthew Paris, Henry III was greedy and unjust and treated the Church badly.

Out of chronicles history proper developed, for history is telling a story. That is not merely recording events but explaining them. In explaining the development of events, some judgement is made. Historians are as prejudiced, as biased, as other human beings. A good historian is one who both gives the evidence on which he bases his judgement and also makes clear to his readers that there are other points of view. A historian has to be like a scientist in the way he treats evidence. The facts must be tested most carefully. But in interpreting the facts, in telling a story based on them, the historian needs the imagination and sympathy for different points of view of the artist.

To make sense out of the thousands of years of human history, historians have divided the past into periods. The Middle Ages is the name we give to the period of time between Ancient and Modern history. Ancient history is the story of classical Greece and Rome. Modern history is the story of the period following the Renaissance, the Reformation and the Discovery of America.



These are divisions invented by historians simply to help us understand the past and later historians, with a different point of view, may invent new period divisions.

Ancient history and Medieval history (the history of the Middle Ages) are difficult to write because there is very little evidence about many events in some periods (see Dark Ages). Modern history is made difficult because there are more records than any one historian can read. Contemporary history is even worse. There are not only the handwritten or typed private records, letters and diaries, but an immense quantity of printed official reports and newspapers. Photography has preserved for us a completely new type of evidence. We have only descriptions of what Gladstone or Disraeli were like as speakers but we can hear and see Sir Winston Churchill on films. Contemporary history presents another problem to the historian. There are many records which are still secret. Governments and large firms keep their records private for many years. The historian does his best to explain what happened and why from the evidence he has. He knows that any day someone may make public new evidence which shows that his interpretation was wrong. The records of countries defeated in wars or governments overthrown by revolutions are published, but the winning countries and the new, revolutionary governments keep their records secret. So we only have the full evidence for one side of the story.

There is quite another way of looking at history. This is to divide it, not by periods of time, but by subject matter,

CHART OF COMPARATIVE WORLD HISTORY

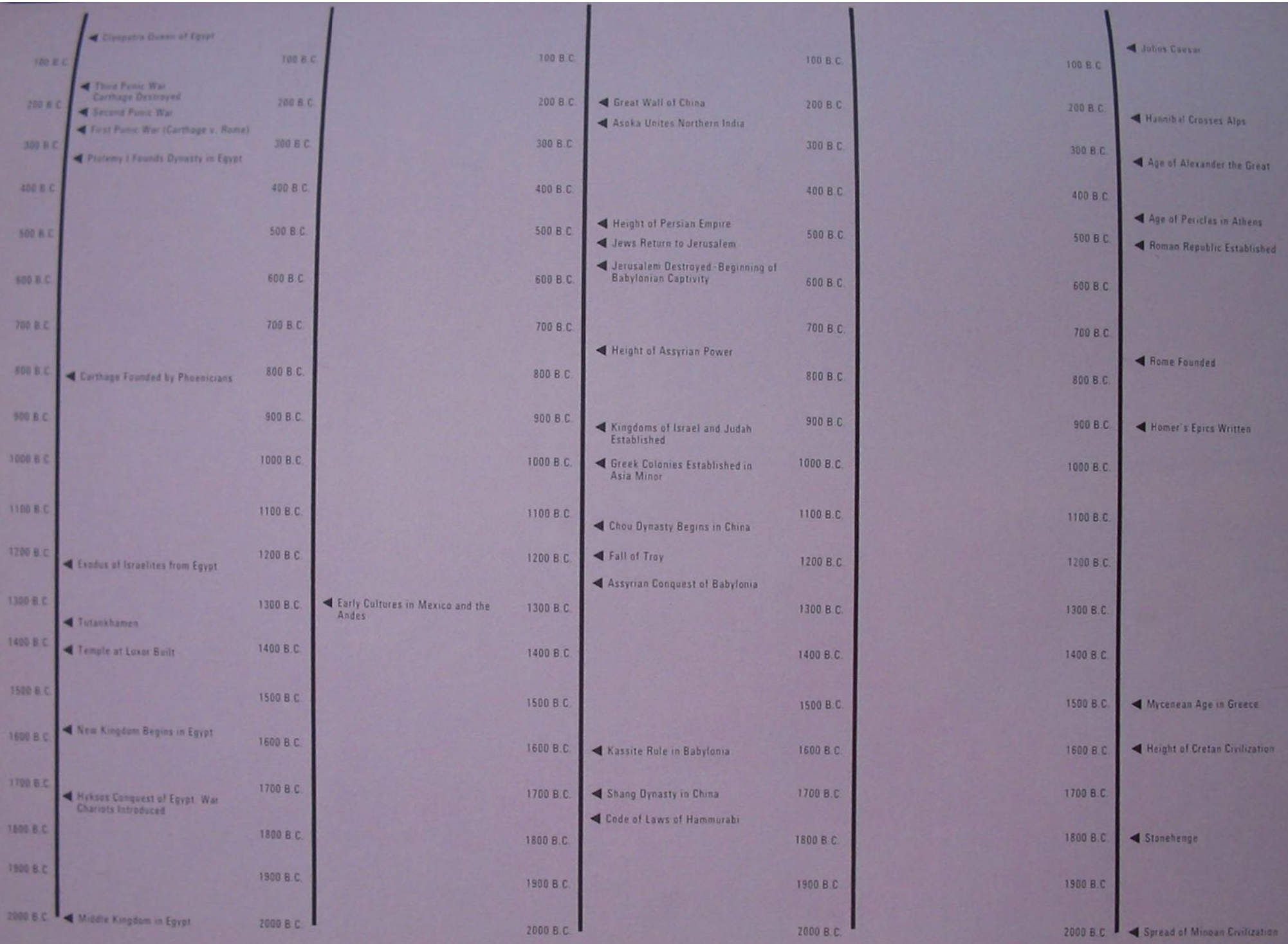


CHART OF COMPARATIVE WORLD HISTORY

AFRICA

- 2000 A.D.
- 1900 A.D.
  - Emergence of African States Begins
  - Boer War
  - Opening of Suez Canal
- 1800 A.D.
  - British Exploration of Africa Begins
- 1700 A.D.
  - Capetown Founded By Dutch
- 1600 A.D.
  - British Slave Trade Begins
- 1500 A.D.
  - Diaz Rounds Cape of Good Hope
  - Portuguese Begin to Explore West Coast
- 1400 A.D.
  - Ibn Batuta Crosses Sahara
- 1300 A.D.
  - Height of Mandingo Empire
- 1200 A.D.
- 1100 A.D.
  - Height of Kingdom of Ghana
- 1000 A.D.
  - Arabs Begin Slave Trade
- 900 A.D.
- 800 A.D.
- 700 A.D.
  - Islamic Conquest of North Africa
- 600 A.D.
- 500 A.D.
- 400 A.D.
  - Vandals Begin Conquest of North Africa
- 300 A.D.
- 200 A.D.
- 100 A.D.

AMERICAS

- 2000 A.D.
  - U.S. Explodes First Atom Bomb
- 1900 A.D.
  - Opening of Panama Canal
  - American Civil War
- 1800 A.D.
  - American Declaration of Independence
- 1700 A.D.
- 1600 A.D.
  - Founding of Jamestown, First Permanent English Settlement in America
- 1500 A.D.
  - Pizarro Conquers Peru
  - Columbus Discovers West Indies
- 1400 A.D.
  - Height of Aztec Civilization
- 1300 A.D.
- 1200 A.D.
- 1100 A.D.
  - Height of Inca Civilization
- 1000 A.D.
  - Leif Ericsson Discovers North America
- 900 A.D.
- 800 A.D.
- 700 A.D.
- 600 A.D.
- 500 A.D.
- 400 A.D.
  - Height of Mayan Empire
- 300 A.D.
- 200 A.D.
- 100 A.D.

ASIA

- 2000 A.D.
  - Korean War
  - Chinese Revolution
- 1900 A.D.
  - Indian Mutiny
  - British Settlement at Singapore
- 1800 A.D.
  - British—French Struggles in India
- 1700 A.D.
  - Britain Acquires Calcutta
  - Manchu Dynasty Begins in China
- 1600 A.D.
  - Akbar Becomes Mogul Emperor
- 1500 A.D.
  - Suleiman The Magnificent, Sultan of Turkey
- 1400 A.D.
  - Ming Dynasty in China
- 1300 A.D.
  - Marco Polo Journeys Through East
  - Kublai Khan, Mongol Emperor in China
- 1200 A.D.
  - Mongols Under Genghis Khan
  - Gunpowder used in China
- 1100 A.D.
  - Beginning of Crusades
- 1000 A.D.
  - Khmer Civilization Flourishes in Cambodia
  - Sung Dynasty in China
- 900 A.D.
- 800 A.D.
  - Harun al-Rashid, Caliph of Baghdad
- 700 A.D.
  - Mohammed
  - Tang Dynasty Begins in China
- 600 A.D.
- 500 A.D.
- 400 A.D.
- 300 A.D.
  - Gupta Dynasty Reunites India
- 200 A.D.
  - Break-up of Chinese Empire
- 100 A.D.
- Jesus Crucified

AUSTRALIA, NEW ZEALAND AND PACIFIC

- 2000 A.D.
- 1900 A.D.
  - Introduction of Meat Refrigeration on Ships
- 1800 A.D.
  - British Convicts Landed at Botany Bay
- 1700 A.D.
  - Tasman Discovers New Zealand
- 1600 A.D.
  - Dutch Explore Australian Coast
- 1500 A.D.
  - Portuguese Traders Reach Australia
- 1400 A.D.
- 1300 A.D.
- 1200 A.D.
- 1100 A.D.
- 1000 A.D.
- 900 A.D.
  - Maoris Reach New Zealand
- 800 A.D.
- 700 A.D.
- 600 A.D.
- 500 A.D.
- 400 A.D.
- 300 A.D.
- 200 A.D.
- 100 A.D.

EUROPE

- 2000 A.D.
  - Second World War
  - First World War
- 1900 A.D.
  - Crimean War
- 1800 A.D.
  - Napoleon Defeated at Waterloo
  - French Revolution
  - Watt's Steam Engine
- 1700 A.D.
  - Peter the Great, Tsar of Russia
  - English Civil War
- 1600 A.D.
  - Spanish Armada
  - Reformation Begins
- 1500 A.D.
  - First Printing From Movable Type in Europe
- 1400 A.D.
  - Hundred Years' War Begins
- 1300 A.D.
  - "Model" Parliament in England
- 1200 A.D.
  - Magna Carta
- 1100 A.D.
  - Norman Conquest of England
- 1000 A.D.
- 900 A.D.
  - Norsemen Settle in Iceland
- 800 A.D.
  - Charlemagne Crowned Holy Roman Emperor
- 700 A.D.
- 600 A.D.
  - Lombard Kingdom Founded in Italy
- 500 A.D.
  - Visigoths Established in Spain
  - Rome Sacked by Vandals
- 400 A.D.
  - Division of Roman Empire Into East and West
- 300 A.D.
  - Christianity Tolerated in the Roman Empire
- 200 A.D.
- 100 A.D.
  - Roman Empire at Greatest Extent

such as constitutional, military, social and economic history.

The first great historian was the Athenian Thucydides, who wrote the History of the Peloponnesian War (see Greece, Ancient). He was writing contemporary history, for he lived through the war and took part in it. A landmark in the development of history was Edward Gibbon's *The Decline and Fall of the Roman Empire,* which was published between 1776 and 1788. Gibbon used cool, 18th-century reason to judge the confusion of the early Christian era. In the 19th century German historians developed history as a science, by the detailed analysis of small pieces of history (this is called a *monograph*) and by critical studies of the evidence available.

History has become extremely popular today. Histories of all kinds and historical novels (imaginary reconstructions of past events) sell extremely well. This is not surprising. If the proper study of mankind is man, history provides an inexhaustible source of study, for it contains all that all men have ever done, or as much as we can find out about it.

Talking points

*History is made by individual people; but some historians think that there is an impersonal *force of history* that has made certain events inevitable as a result of previous events. Discuss this theory.

*Henry Ford said that 'history is bunk', meaning that past events have no influence on the present. Do you agree with this?

*Historians can be biased. Read two accounts of a historical event by historians of different nationalities. Compare how they have emphasized some facts and omitted others to put over their own point of view.

Articles to read

Anglo-Saxons; Barbarians; Crusades; Egypt, ancient; Greece, ancient; Religions; Roman Empire.

Hitler, Adolf (1889-1945), was dictator of Germany from 1933 until his death. He increased his and Germany's power rapidly, persecuting Jews and using the *Gestapo* (secret police) to maintain a strict obedience to his rule. He tried to conquer the world and make Germany supreme. But his rule eventually led to the defeat and break-up of his country.

Hitler made enemies of all other countries, and he was not skilful in making war because he trusted his own feelings rather than the wisdom and experience of his generals. But he was a forceful man, and as a speaker he was able to persuade great crowds to follow him and his way of thinking. He got people to support him and die for him, even when his actions were evil. His worst crime was to put more than five million Jews to death in concentration camps (prisons). Before this his party, the *Nazis,* had stolen Jews' property, forcing many to flee from the country.

Adolf Hitler became the leader of the German people from 1933-1945. He swayed millions of people by his fiery speech-making, and ruled as a supreme dictator until defeated in World War II.

Hitler was born at Braunau, in Austria, and was the son of a customs official. When World War I started in 1914, he joined the German army, in which he became a corporal. From 1919 onwards he was a politician. He soon

Fishing boats tied up alongside in Constitution dock in Hobart. The city has some fine early buildings that stand side by side with modern blocks of flats and offices.

became leader of the National Socialist German Workers' party, or Nazis, but it made slow progress. When he tried to take over the government in 1923, he was put in prison. There he wrote *Mein Kampf* (My Struggle), a book about his ideas and aims.

In 1933, as chancellor, he was head of the Nazi government, and he soon made himself dictator. He built up a powerful army, and began his conquest of Europe. When he invaded Poland in 1939, Britain, who had promised to support Poland, declared war on Germany. The United States and the U.S.S.R. joined the Allies against Hitler in 1941. When they defeated Hitler in 1945, he killed himself.

Hobart, the capital of Tasmania, is the second oldest city in Australia. It is located on the south-east coast of Tasmania at the head of Storm Bay and is an important port. Over 127,000 people live in the metropolitan area.

Hobart is built on the estuary of the River Derwent. Here the river forms a deep natural harbour. Large cargo ships carry fruit, hops, meat, wool, timber, animal hides and other goods out of the port. The Tasman Bridge, constructed in 1963, spans the river, linking Hobart with suburbs on the east bank. To the west, Mt. Wellington rises above the city.

Industries in Hobart include the refining of zinc ore, fruit canning, flour milling and the manufacture of chemicals and textiles. The University of Tasmania was founded in the city in 1890. The Parliament House, state library and museum are other landmarks. The Queen's Domain is the largest park.

A site at Sullivan's Cove was first settled in 1804 and called Hobart Town, after Lord Hobart the British Colonial Secretary. The settlement became a city in 1842, and its name was shortened in 1881. A busy whaling industry contributed to the city's growth in the 1800's and

industry was encouraged when hydro-electric power became available in the 1900's.

Right: This little girl has made a hobby out of collecting sea-shells. A passing interest may become the hobby of a life-time.

Hobbies are interests that people enjoy during their leisure time. People follow their hobbies chiefly for enjoyment and relaxation, but hobbies can be useful as well. They can teach us skills that we might not otherwise learn and can sometimes even provide a way of earning pocket-money. Mostly, however, hobbies are good because they keep us active, and prevent us from getting bored. Having a hobby can be very important for invalids and others with time on their hands.

The list of possible hobbies is endless. What hobby we adopt may depend on our temperament or where we live. Some people enjoy physical activity or being outdoors. Their hobbies might include team or individual sports, dancing, hiking, camping or fishing. Hobbies of this kind help to keep people fit and healthy.

Other people prefer doing things with their hands. They may sew, knit, build models or take up leathercraft or metal-work. Artistically inclined people can draw, paint or sculpt as a hobby and lots of people play musical instruments. A few crafts require expensive tools and supplies, but many can be done quite cheaply. Crafts can be studied at part-time or evening classes or from books from a local library.

Collecting things such as stamps, dolls or rocks is one of the most popular types of hobbies. The enjoyment comes from learning about the things collected, going out and finding new acquisitions and then cataloguing and displaying the collections.

Hockey is an 11-a-side team ball game played on a field 100 yards long, 55-60 yards wide. Each player has a stick, flat on one side and curved at the end, to propel the ball. The ball is covered in white leather, is up to 9¼ ins. in circumference, and weighs 5½-5¾ oz.

The goals are 12 ft. wide and 7 ft. high. In front of each goal is a semi-circular area, with a radius of 16 yards, outside which no shot at the goal scores. Play starts, and may be re-started, by a bully-off in which a player from each team taps first the ground and then his opponent's stick three times alternately before playing the ball.

Two halves of 35 minutes each are played. Positions and rules are somewhat similar to 'soccer' except the ball may only be propelled with the stick or stopped dead with the hand. A goalkeeper is allowed to kick the ball, or stop it with any part of his body while the ball is within his area.

Early forms of hockey were played by the Ancient Egyptians, Greeks, Romans

Right: A traditional hockey game in progress.

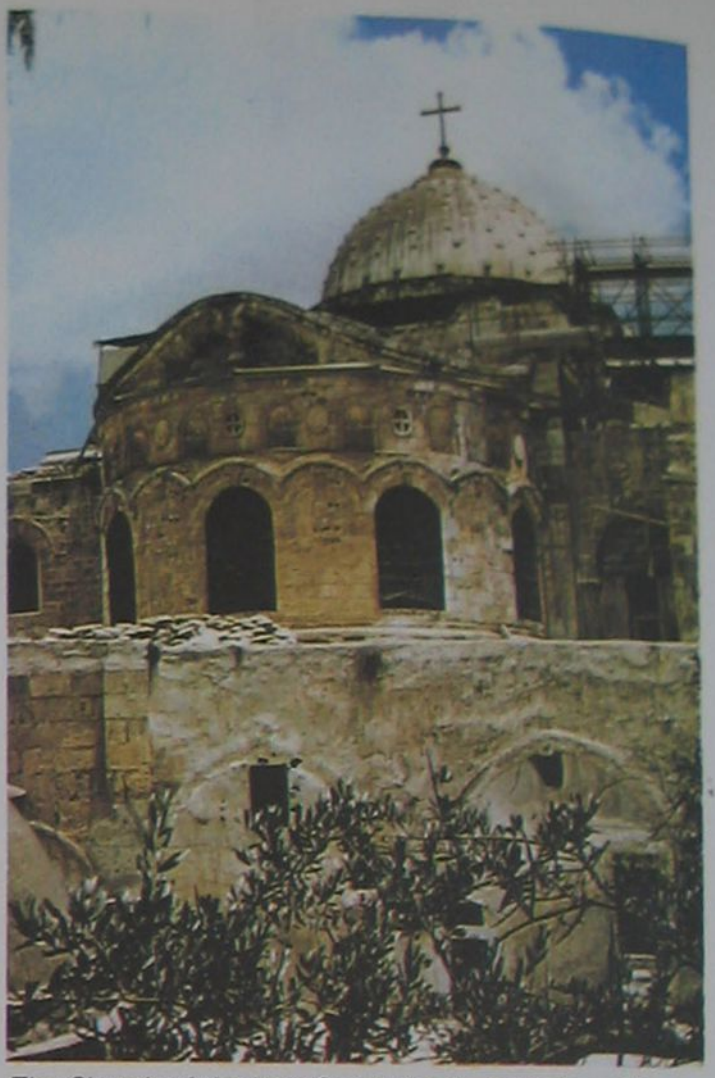
and Aztec Indians. Blackheath, founded in 1861, is the oldest club. England formed the Hockey Association in 1886.
(See Ice Hockey.)

Holy Land is a territory on the eastern border of the Mediterranean Sea. It is considered sacred by Jews, Christians and Muslims alike. The history of the Holy Land goes far back into antiquity. Many of the events of the Bible took place there. In biblical times, the land was called *Canaan*. Later it was known as *Palestine*.

The Jews look upon the Holy Land as the homeland promised to them by God. The ancient city of Jerusalem has special significance, because it was there that King Solomon built the Temple.

For Christians, the Holy Land is sacred because of its connections with the life of Jesus. Bethlehem was his birthplace, and Nazareth his home. The hill of Calvary in Jerusalem was the place where he was crucified. During the Middle Ages, Christian knights from Europe fought wars in the Holy Land to free it from Turkish rule. These wars were called Crusades.

The Muslims, too, consider the Holy Land theirs by right. To them Jerusalem is also the site of a sacred shrine.



The Church of the Holy Sepulchre in Jerusalem. It is built on the site where, according to tradition, Jesus was crucified.

Holy Roman Empire After the collapse of the Roman Empire in the West, the Pope in Rome was able to lead the whole Church in the old Roman lands of Western Europe. At home he needed help against the strong kings of Italy. In 754 he found an ally in Pepin, King of the Franks.

There was still an Emperor in the East in Constantinople, and the Pope wanted to prevent him from interfering in the West. On Christmas Day, 800, Pope Leo III crowned Charlemagne, Pepin's successor, Emperor in Rome. So there was once more a Roman Emperor in the West.

After Charlemagne's death the title meant little until it was taken by Otto III in Germany. As things turned out the Popes had more trouble than help from Emperors. Germany suffered too because its kings wasted effort in Italy trying to dominate the Roman Catholic Church for their own political ends.

From the end of the 1300's, the Emperor always came from the Habsburg family, the rulers of Austria, the strongest of the German states. Seven Electors chose the Emperor, but the Prince with the largest army had the loudest voice. The Empire's parliament, called the Diet, was under the Prince's control.

In the late 1700's when the Holy Roman Empire was falling into decay, Voltaire made the following damning remark about it: 'This agglomeration which was called and which still calls itself the Holy Roman Empire, was neither holy, nor Roman, nor an empire'.

The map above shows the extent of the Holy Roman Empire. It lasted from 800 A.D. until 1806, when it was broken up by Napoleon Bonaparte. From then on, the Holy Roman Emperor was known only as the Emperor of Austria.

As some German states grew bigger in the 1500's, so the Emperor began to lose power. The Thirty Years War of the mid-1600's completely disrupted central Europe, and when it was over, the power of the Emperor was further reduced. The rising importance of Prussia lessened the influence of the Holy Roman Empire in Germany in the 1700's and it finally came to an end when the last Emperor, Francis II, was defeated by the French under Napoleon in 1806. At the end in 1806, he was really simply the Emperor of Austria.

Homer was the author of two great epic poems of ancient Greece, the *Iliad* and the *Odyssey*. Both poems are long and wonderfully dramatic. The *Iliad* recounts the events of the Trojan War, fought between Greece and Troy. The *Odyssey* tells about the later travels of Odysseus, the hero who led the Greeks to victory in that war. Homer probably drew on traditional stories in writing the poems. Little is known about Homer's life. He probably lived in the 800's BC in what is now Turkey. According to legend, he was blind.

Honduras is a republic in Central America. It has coastlines on the Caribbean Sea in the north, and the Pacific Ocean in the south. Its interior is mountainous and forested, except in the north. Its climate is varied, but generally hot. The area of Honduras is 43,277 square miles. Most of the 2,535,000 people are *mestizos* (people of mixed Indian and European descent). They make a poor living by cultivating bananas and coffee, and raising livestock. Sugar is an important cash crop and accounts for one third of the country's exports. Tegucigalpa, the capital, is the biggest city.

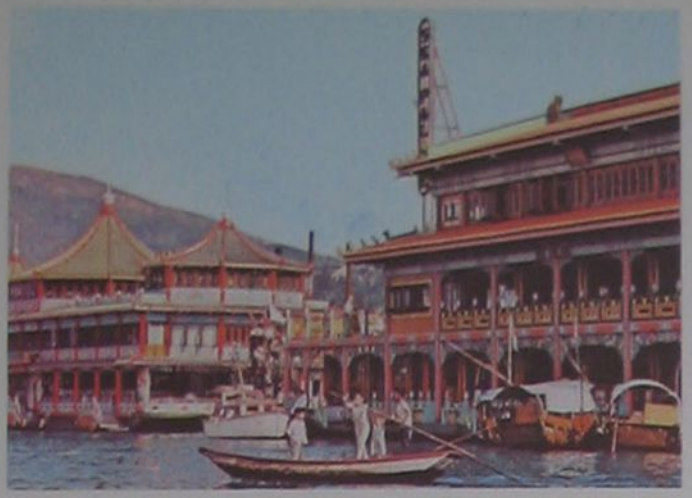
A location map of Honduras.

Hong Kong, a British colony, lies on the coast of southern China. The colony includes 235 small islands and a part of mainland China. Almost all of Hong Kong's people are Chinese. Hong Kong's capital, Victoria, lies on the northern coast of Hong Kong island, opposite the mainland city of Kowloon.

The colony has a humid sub-tropical climate, with an annual rainfall of 85 inches. Most of this falls in summer, when gales and typhoons lash the area. But to obtain enough water in the dry winter, Hong Kong has to import some from China.

Many shack-dwellers and roof-squatters have now been rehoused in new flats. About one family in 25 are fishermen who live in boats.

China surrendered Hong Kong island to Britain in 1842, after the Opium War. In 1898, parts of mainland China and several islands were leased to Britain for 99 years. Chinese refugees poured into Hong Kong during the 1950's and 1960's.



The 'Tai Pak' and the 'Sea Palace', two of Hong Kong's famous floating restaurants.

Right: A Chinese workman, wearing the traditional coolie's hat, weaves a roof from straw. Many of Hong Kong's inhabitants live in straw-roofed shacks, but these are gradually being replaced by modern blocks of flats.

The export of manufactured goods led to rapid economic development during this period.

Facts and Figures
Area: 398 square miles.
Population: 4,089,000.
Capital: Victoria.

Horizon This is the farthest distance one can see. A person standing at sea-level looking out to sea can see only about three or four miles. The curvature of the Earth prevents him seeing any farther, and at the horizon, the sea and the sky appear to meet. But the higher he climbs above sea-level, the farther he can see. From an aircraft or a mountain a mile high, the horizon is 100 miles away.

Hormones are chemical substances *secreted* (passed into the bloodstream) by the *endocrine glands* (the ductless glands) of the body. The bloodstream carries the hormones to other parts of the body, where they play a major role in regulating *metabolism* (the body's rate of activity), growth and sexual reproduction. Hormones are produced by all higher organisms, including plants as well as animals.

Proper levels of hormones in the body are necessary for health and well-being. Where necessary, doctors treat patients for over-secretion or under-secretion. Diabetics, for example, are given doses of *insulin*, a hormone normally produced in the pancreas which is necessary for the digestion of sugar. In agriculture, hormones are being increasingly used to improve crops and livestock.

In vertebrates, important hormones are produced by the pituitary gland, the pancreas, the thyroids, parathyroids, adrenals, testes (male) and ovaries (female). (See Glands.) The pituitary is often called the 'master gland' because it stimulates other glands to secrete their hormones. It also affects the body's overall size and growth. *Thyroxine* (thyroid hormone) affects metabolism. *Adrenalin* (one of the adrenal hormones) mobilizes the body to meet emergencies by stimulating heart-beat and breathing. *Testosterone* is the principal male hormone, and *Oestrogen* the principal female hormone. *Auxins* are the chief growth hormones of plants.

Horns and antlers are the hard projections that grow from the foreheads of many hoofed animals. They are mainly defensive weapons, but are sometimes used in courtship displays.

The horns of sheep, cattle and antelopes consist of a core of bone surrounded by a tough, horny material. This is the same material that forms nails and hooves. These horns often curve round into elaborate spiral designs. Both male and female animals usually have horns, and they keep them throughout life.

The branched horns of deer are called *antlers*. They have no horny covering over the bone. In most species of deer only the male has horns, but both male and female reindeer have them.

Deer antlers fall off each years, usually in the spring, but a new pair grows very quickly. The new antlers are at first

P. J. E. Clapham

1. Moose
2. Moufflon Sheep (the only wild sheep in Europe)
3. Impala
4. Rhinoceros
5. Wapiti or elk

Animals with horns or antlers.

covered with soft skin and are then said to be *in velvet*. This skin soon tears off, leaving the bone exposed. Young deer have very simple antlers with no branches, but each year's antlers are larger and have more branches.

Rhinoceros horns have no bony material. They are like tufts of hair welded into solid masses.

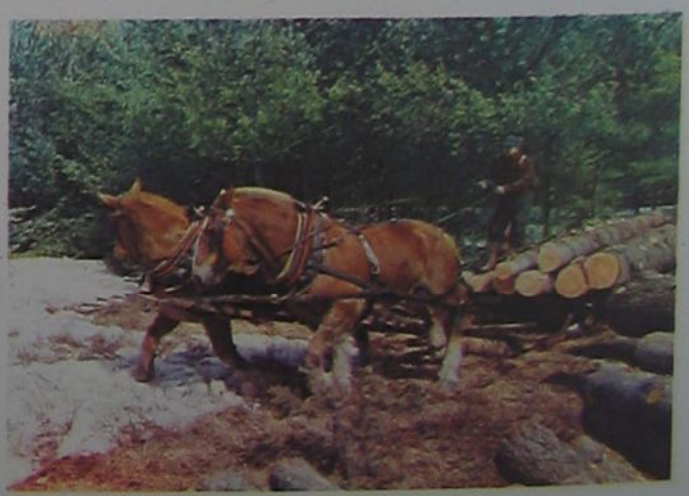
Horse The horse has been used to carry man and his goods—and to pull ploughs, carts, barges, and other vehicles—for thousands of years. Until the 1800's, horses provided the quickest and most important way of travelling on land. Then the locomotive replaced them for long-distance travel. The coming of motor vehicles in the 20th century largely replaced horse-drawn transport in towns and cities. Today, only a few working horses are used, but many horses are kept for racing and other sports and for such entertainment as circuses. (See Riding.)

The horse was first domesticated about 2000 BC by the peoples of the Middle East. The Romans are credited with having been the first people to use iron horse-shoes. The horse was not used in farming in Europe until about the 1100's because a suitable harness had not been invented until then.

As with most important tamed animals, men have developed many breeds (varieties) of horses. Although they all belong to the same species, they may be black, brown, grey, white, or colours in between. Some have mixed colours.

Draught horses—those used for pulling heavy loads—are thick-set, with strong muscles, thick legs, and broad hoofs on their feet. They may weigh as much as a ton. Saddle horses, which are used for riding, may be only half this weight, and ponies are even smaller. Thoroughbred horses are an important breed developed

Horses working in the forests of Washington State, U.S.A., where they are used to haul heavy timber in the extensive logging operations. The logs are carried from the forests to be floated down-river to the mills.



in England and used for racing and show-jumping.

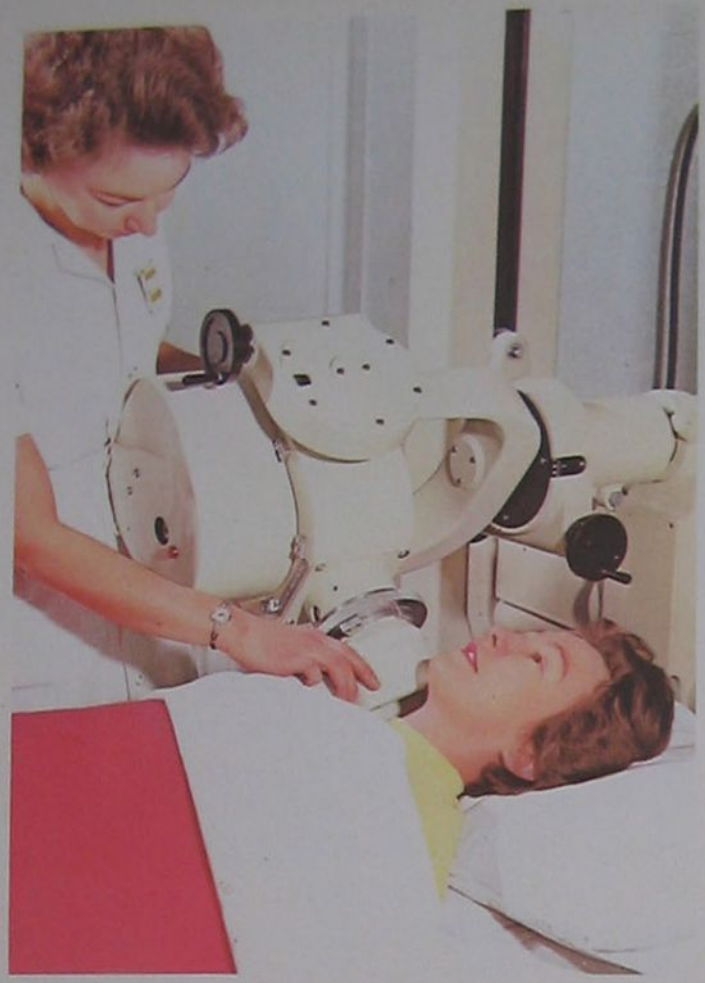
The ancestors of modern horses were small creatures, the size of dogs. They lived 50 million years ago. Living in open grasslands where speed was important to escape from enemies, they gradually evolved into the fast, hoofed, grass-eating horses of today (see Evolution). Within the last few thousand years, there were many species (kinds) of wild horses living in most parts of the world. But the only truly wild horse living today is that of the Altai mountains of northern Asia. Other 'wild' horses are simply the wild descendants of domestic breeds.

Hospitals are places where sick people are looked after and given medical treatment. Some are specialized institutions, treating only patients, say, with eye trouble or diseases of the chest; others are general hospitals. In these, patients with every kind of complaint, from tonsilitis to broken limbs, are cared for until they are well enough to go home.

The earliest hospitals were temples, where the sick came to rest and pray to their gods for recovery. In ancient Greece, these temple-hospitals were dedicated to the god Aesculapius, known as the father of medicine. During early Christian times, all pagan institutions in the vast Roman empire were closed. However, the job of tending the sick was still a religious duty, and for over a thousand years this work was done by Christian monks and nuns.

The tradition of monastic hospitals was broken between 1536 and 1540. Henry VIII of England ordered the closing down of all English monasteries, and in those four years, some 500 were destroyed, many of which had hospitals attached to them. The next two hundred years saw very little advance in caring for the sick. Local parish hospitals were provided by law, but these were totally inadequate. Not until the 18th century, with the founding of a number of hospitals by private individuals, did the picture begin to improve. Even then, conditions in European

A horse race at Doncaster. Race horses are usually superb thoroughbreds that are bred purely for speed. Many different breeds of horse have evolved through the ages—from the large, powerful shire horse to the tiny Shetland pony.



and American hospitals, both religious and secular, were most insanitary and unhealthy.

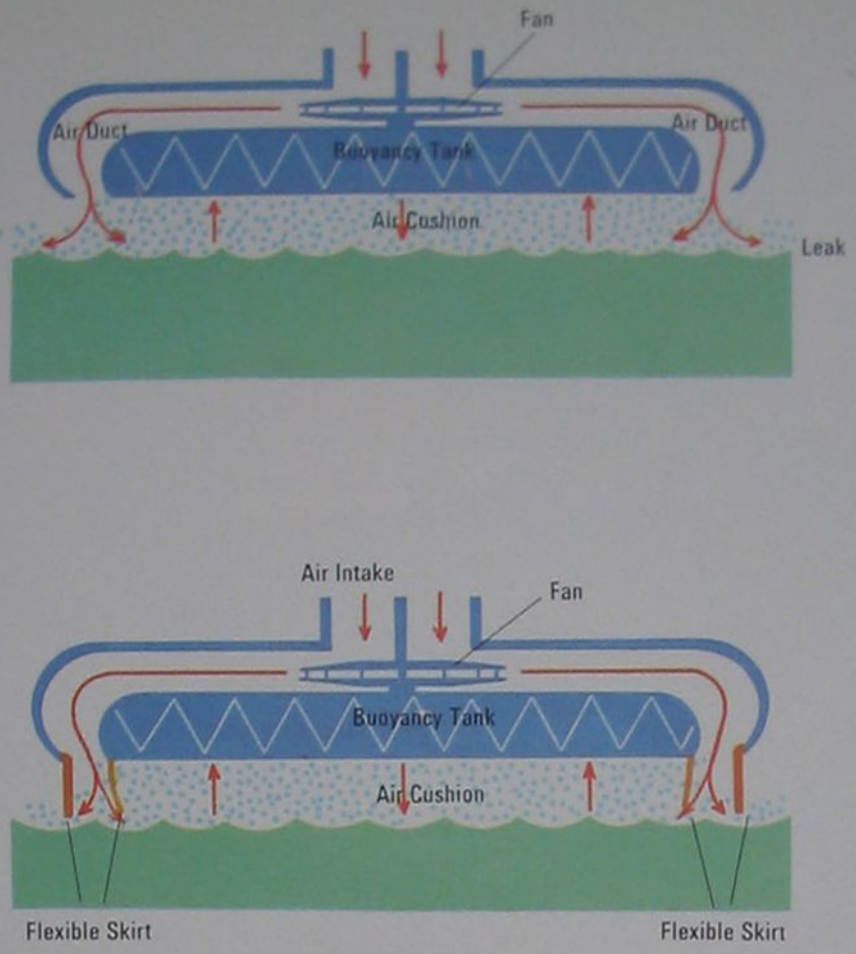
Modern hospitals are light and airy, and are kept spotlessly clean. They are staffed by doctors and nurses and many other trained people, such as laboratory technicians, radiologists, who give X-rays, and pharmacologists, whose job it is to prepare medicines prescribed by the doctors. Besides caring for the 'in-patients' staying in the hospital, some of the staff work in the 'out-patient' clinics.

House plants are those grown indoors for decoration and display. Until the early 1900's, the only plant found in the vast majority of homes was the aspidistra. Today, the picture is quite different, and an array of quite unrelated species adorn many homes.

House plants can be grown for their leaves or for their flowers. The rubber plant has become a popular house plant. It has thick, shiny dark-green leaves. The

Modern hospitals perform a variety of specialized services for patients and need a great many skilled people and a range of expensive equipment. Top left: A patient undergoing radio-therapy treatment for an ailment of the neck, at St. Thomas's Hospital in London, England. Top: A nurse at the Royal Edinburgh Infirmary, Scotland, adjusts the saline drip which is carrying essential salt and fluids to a patient lying in bed. The fluid is fed through a vein in the sick person's arm.

Above: A recovery room outside an operating theatre. A patient at St. Bartholomew's Hospital, London, is ready to be taken back to the hospital ward after an operation.



The hovercraft is an air cushion vehicle which is designed to skim over the surface of water or land, avoiding obstacles or waves. A cushion of air is maintained between the craft and the surface by driving air at pressure under the hovercraft. This cushion supports the weight of the craft and also acts as a shock absorber, but it is mainly intended to keep the craft clear of the surface. The hovercraft's air cushion is like a leaking tyre, in principle. Air must be pumped in continuously in order to maintain the necessary lift. The top diagram shows a hovercraft which uses an air cushion. The lower diagram shows how leaks can be reduced by fitting flexible skirts.

rubber plant's natural home is the tropical forest, so it needs protection from full sunlight and from draughts. Ornamental ivy, coleus, and spiderwort are grown for their attractive leaves. Hyacinths and dwarf azaleas are prized for their beautiful blooms.

If you plan to grow house plants, keep the soil moist but not waterlogged, and water less during the winter. Some house plants need to have their leaves sponged occasionally with water to remove dirt which may have gathered on them.

Hovercraft Transport by water is very slow compared with land and air travel. This is because vessels waste most of their power overcoming the resistance of the water. The hovercraft was developed to overcome this trouble. It is designed to skim quickly and smoothly over the surface on a cushion of air. For this reason, it is sometimes called an air-cushion vehicle.

Hovercraft operate equally well over land. This means that special docks and harbours need not be built at hovercraft sea terminals. A concrete ramp is all that is needed. The hovercraft can come straight out of the water and up the ramp. In underdeveloped regions hovercraft are ideal vehicles because they need no prepared road surface.

In the hovercraft, powerful fans force air under the body. The air leaves through inward-pointing jets along the lower outside edge. This forms an 'air curtain' which produces and maintains an air cushion of sufficient pressure to lift the craft. Air must be pumped through continuously to make up for the air loss at the sides.

The air loss is decreased and the depth of the air cushion increased by fitting flexible 'skirts' several feet long around the lower edge of the hovercraft. In this way the hovercraft can ride over high waves or obstacles.

Right: The hovercraft in action is virtually a buoyancy tank with a number of inward pointing jets around its perimeter underneath. On top of its flat surface are the control cabin, the funnel containing the engine and the horizontal fan through which air is sucked and then ejected to form the air cushion. Below: Sir Christopher Cockerell, the inventor of the hovercraft.

Hovercraft may be driven by propellers or by jet engines. They are steered by swivelling either the propeller or fins in the airstream.

Christopher Cockerell, a British engineer, invented the hovercraft in 1955, and the first one, SRN-1, was launched four years later. It made a successful crossing of the English Channel. By 1962, hovercraft were in commercial service in Britain. In 1968, a car ferry carrying 30 cars and 250 passengers was launched for service across the English Channel. The 'hover' principle has also been applied to other forms of transport, too. A French hover train, called the Aerotrain, can travel on a monorail at well over 200 miles an hour.

Hudson, Henry (?-1611), was a British navigator. He was first unsuccessfully employed by an English company to find a route across the north of Europe to eastern Asia. Then he undertook another voyage for the Dutch East India Company. Instead of sailing east, as planned, Hudson sailed west. He reached New York Bay and sailed up what is now called the Hudson River in 1609. With English backing, Hudson made a fourth voyage. This time he reached what is now Hudson Bay. Hudson was left to die by his crew who had mutinied because of disease, starvation and cold.

Hudson Bay is a huge bay or inland sea that cuts into the north of Canada. It is connected to the Atlantic and Arctic oceans. Bordering it are the provinces of Quebec, Ontario and Manitoba, and the Northwest Territories. The Hudson Bay area was once famous for its fur trade. The Hudson river flows into it.

Hugo, Victor Marie (1802-1885), was one of the foremost figures of French literature in the 1800's. Some critics consider him France's greatest poet, but in

English-speaking countries his poems are less known than his novels, especially *The Hunchback of Notre Dame* (1833) and *Les Miserables* (1862). Hugo also wrote plays, essays and criticism. He belonged to the Romantic movement in art.

Hugo was born in Besançon, the son of one of Napoleon's generals. He began writing in his teens. The public recognized his genius from the start. In 1845 he became a member of the Legislative Assembly (the parliament). He went into exile in 1851, because he opposed the ambitions of Louis Napoleon (later the Emperor Napoleon III). He travelled to Brussels, then to Jersey and finally to Guernsey. Hugo continued writing while in exile and upon returning to France 19 years later was hailed as the grand old man of French literature. He is buried in the Panthéon, in Paris.

Humboldt, Baron Alexander von (1769-1859), was a German scientist and explorer who made important contributions to geography, meteorology, geology and biology. From 1799 to 1804, he led an expedition to Mexico, Cuba and South America. He explored the Amazon and Orinoco rivers, collected samples of the plant life of the New World and drew up temperature maps. He also studied volcanoes, tropical storms and the Earth's magnetic field.

Humboldt worked for over 20 years in Paris compiling the report of his expedition. He then returned to his birthplace, Berlin. In 1829 he went to Siberia for the Russian government to study climate and mineral resources. He gave a famous series of lectures at the University of Berlin on the physical universe. They later appeared as a book. The cold ocean current that runs from south to north off the coast of Peru is named the Humboldt Current after him.

Hummingbirds are tiny, brilliant, gem-like birds that live only in the Americas.

A hummingbird feeding at a flower. Their wing speed is so great that they can hover in flight.

They range from Alaska in the north to Tierra del Fuego in the far south. They feed at flowers, eating the nectar and insects caught inside the flower. The smallest of these birds is less than two inches long, not much larger than a bumble-bee. Hummingbirds are related to swifts, and about 320 kinds have so far been discovered.

The smallest birds beat their wings about 70 times a second in flight. This rapid vibration produces a humming sound, from which they get their name. With this extraordinary wing speed they can do almost anything in flight. They can fly forwards, backwards, and sideways, or hover like a helicopter. They are the only birds that can hover as they feed on the wing.

The birds' long tongues are specially adapted for reaching into flowers. They are tube-shaped at the tip, and act as suckers. Some kinds have bristles to help them to scoop up insects. Hummingbirds have weak legs and feet, and find it easier to catch and eat insects in flight than to perch on a branch and eat their food.

The feathers of the male birds vary

enormously in colour and shape. Colours include purple, violet, blue, green, yellow, orange, and scarlet. These hues glitter as the sun catches them. Many of the males also have crests, collars, and tail streamers. The plumage of the females is generally duller.

During migration, some tiny hummingbirds spend 20 hours in the air, and make journeys of up to 500 miles over water.

Hundred Years War This began in 1337 when Edward III of England and Philip VI of France quarrelled over who should rule Aquitaine in southern France. Edward, whose mother was a French princess, then claimed the French crown for himself. England and France remained enemies until 1453, but there were lulls in the fighting.

The English did well for much of the war. Led by Edward III and his son, the Black Prince, they won victories at Crécy (1346) and Poitiers (1356) and captured Calais. During Henry V's reign (1413-22) they defeated the French at Agincourt (1415) and held most of northern France.

English success was due to skilful use of the longbow. It was easier to load and had a faster rate of fire than the crossbow used by the French. French knights and their horses were easy targets for the showers of arrows. When longbowmen fired arrows into the air at the battle of Crécy someone wrote, 'it seemed as if it snowed'.

After Henry V's death the English lost what they had gained. In 1429 French soldiers inspired by Joan of Arc drove the English back from the walls of Orleans. Although Joan was soon captured and burnt as a witch, she had put heart into the French who now fought with much greater spirit. They were also helped by improvements made to cannon by Jean and Gaspard Burcau and used this weapon with much skill.

When peace came in 1453 the English had lost all their lands in France except Calais. However, until 1802 English kings continued to call themselves King of France and to put the fleur-de-lys (the French royal badge) on their coat-of-arms.

Hungary is a small country in central Europe. It has no coastline. Its neighbours are Czechoslovakia, Russia, Rumania, Yugoslavia and Austria.

The central and eastern part of Hungary is a vast, rolling plain. The Danube and Tisza rivers flow across the plain from north to south. Groups of mountains in the north-east are part of the Carpathian Mountains. The Mecsek Mountains, a small, rugged region, is in the south-west. Lake Balaton, the largest lake in central Europe, is in the west. It is more than 50 miles long. The high ridge of the Bakony Forest borders the lake. Vines grow on the south-facing slopes of the ridge. Summers in Hungary are hot and dry and winters are cold.

Nine-tenths of the Hungarians are Magyars, but there are several important minorities. Most people are Christians, the greatest number being Roman Catholics.

The Hungarians make such products as buses, heavy machinery, textiles and trains. Farmers grow such crops as cereals, fruit and sugar beet. Grapes are grown to make wine. Farmers also grow sweet peppers which are dried and made into *paprika*. Powdered paprika is a spice used to flavour the national dish, called *goulash*. Fishing is important and Hungary has reserves of such minerals as bauxite, coal, natural gas and petroleum.

The Magyars were *nomads*—that is, a wandering people—who settled in Hungary in the A.D. 800's. Hungary had come under Austrian rule in 1687, but became a separate state in 1918. During World War II, Hungary fought Russia, and was occupied by Russian troops in 1945. A communist régime was set up. In 1956, the people rebelled against the communist government, but Russia sent troops in to crush the revolt.

Hungary was once called the granary of Europe because of its vast plains of wheat and maize. Much of the land remains under grain crops, though its vast plains are also grazing lands for cattle, and support the breeding of horses by the *csikos*, or horse-breeders, like the one pictured here on the left.

Facts and Figures
Area: 35,919 square miles.
Population: 10,315,000.
Capital: Budapest.

Hungary is famous for its wines and especially the wine known as Tokay which comes from grapes grown in the volcanic hills of the Hegyalja region in the north-eastern part of the country where there are more than 118 square miles of vines. The grape harvests are invariably celebrated with open-air picnics and festivals like the one pictured above.

Work on the land in various forms of agriculture still remains a big source of employment for Hungarian people though much of the country is now industrialized. Peasants and farm workers still retain many of their colourful costumes (see above) and country traditions. They are especially skilful in embroidery.

Huntingdonshire and Peterborough, an inland county of east central England, was formed in 1965 by the union of the county of Huntingdonshire and the Soke of Peterborough. Its area is 365 square miles. There are low hills in the south and west, but most of the land is flat and well-wooded. Part of the county, in the east, lies in the fens. Much of this formerly marshy land has been reclaimed and is now one of the most fertile areas in England. The chief river is the Great

Ouse. The Nene, flowing from west to east, was formerly the boundary between the two parts of the county. Farmers raise some livestock, but chiefly they grow crops. Wheat, barley and sugar beet are important, and large quantities of vegetables are produced in the fenland districts. There is some food processing and farm machinery and bricks are manufactured. The county town is Huntingdon, but Peterborough is larger. Other towns include Godmanchester, Old Fletton, St. Neots, St. Ives and Ramsey.

Hurricane A hurricane is a violent, swirling storm in which winds blow spirally inwards. Most hurricanes form within 20° of the Equator. The heat of the tropical sun *evaporates* (turns into vapour) large amounts of water from the sea to form a deep layer of warm, moist air. Some weather experts believe that a *depression* (centre of low pressure) forms in the upper air (above 10,000 feet), breaking the barrier separating the moist air below from the dry air above. This allows the surface air to rise rapidly to great heights like a pillar from the sea. As the air rises, it cools, and the water vapour it contains condenses to form thousands of tons of rain. In this way the hurricane is 'fed', because during this process the moisture gives up the heat that caused it to evaporate from the sea.

Wind speeds inside a hurricane range from 75 to almost 200 miles an hour. Hurricanes may be 300 miles across, and travel at about 20 miles an hour. At the heart of the storm lies a region of calm air, about 15 to 30 miles across, called the *eye*. It is ringed by howling winds and towering clouds. In the eye, the temperature is high and the pressure extremely low.

Hurricanes usually develop in early autumn well east of the West Indies in the Atlantic Ocean. The storms travel westwards at first, until they reach the Gulf of Mexico or Florida. Then they either continue over Mexico or, more often, veer northwards. Similar storms in the North Pacific are called *typhoons* or *tropical cyclones*.

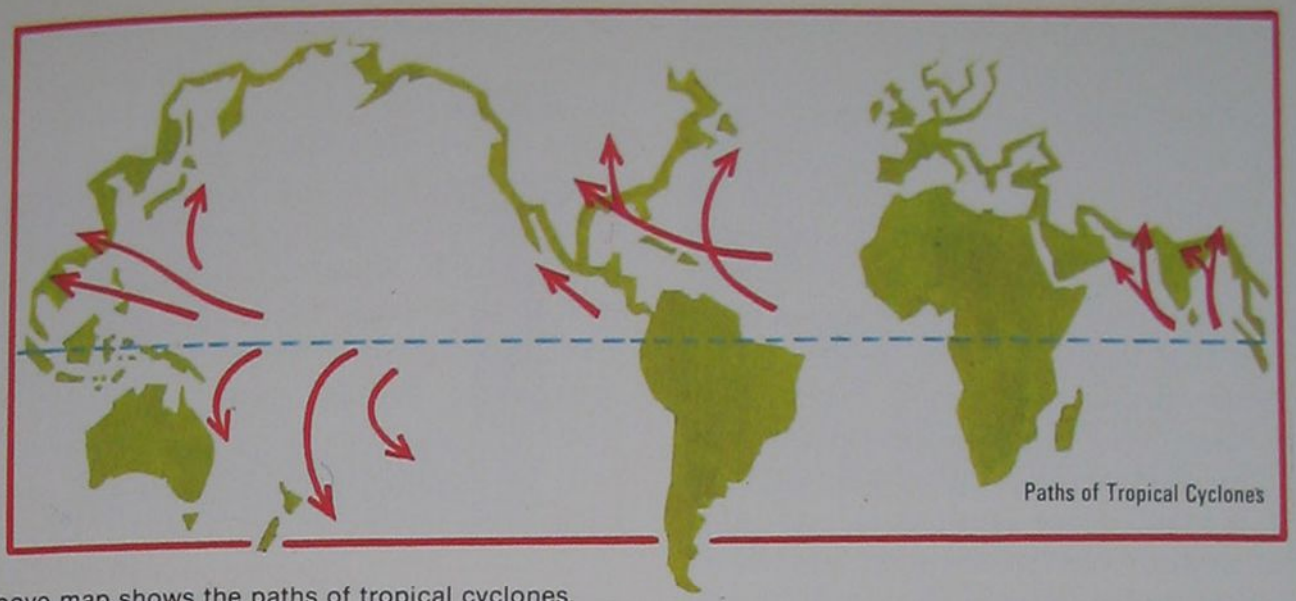
The few hurricanes that actually cross the coast cause tremendous damage at first. But once over land, hurricanes usually die down fairly rapidly, partly because of friction with the ground, and partly through lack of the enormous quantities of moisture-laden air needed to feed them. In the United States, which suffers greatly from hurricanes, they are given girls' names, such as 'Hurricane Dora'. Their paths are plotted, and people in areas likely to be affected are warned.

Hwang Ho is the second longest river in China. It flows about 2,900 miles in northern China into the Yellow Sea. The Hwang Ho, which means Yellow River, is so called because of the large amount of yellow mud it carries. This mud comes from the yellow *loess* soils of northern China which have been washed into the river.

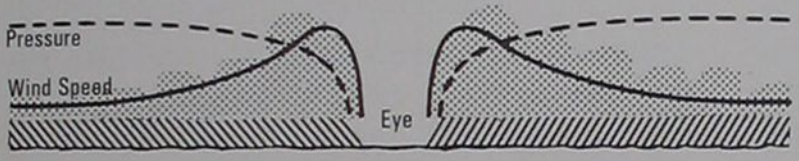
Much of the mud sinks to the bottom of the river channel. In places, the level of the river is much higher than the plain. As a result, the river sometimes floods. Artificial *levees* (banks) have been built to hold back the water. The river has another name, *China's sorrow*, because of the thousands of people it has drowned and the damage it has done. But the mud spread during floods has created very fertile soils.

Hybrid This is the name given to a plant or animal whose parents are of different species. Only fairly closely related species can interbreed to produce hybrids. The horse and the donkey, for example, can interbreed to produce mules or hinnies.

Hydraulic power is the force derived from a fluid when flowing or under pressure. Hydraulic power has been used since ancient times to turn waterwheels and mills. Modern types of hydraulic machines includes turbines and various



The above map shows the paths of tropical cyclones. The south-western area of the North Pacific Ocean has the greatest number of tropical cyclones and these 'typhoons' often surpass the Atlantic hurricanes in intensity.



The most characteristic feature of a hurricane is the central 'eye' (see diagram above) which is a region of calm air between 15 and 30 miles wide which lies at the very heart of the storm ringed by howling winds and boiling clouds. In the eye of the hurricane the temperature is high and the pressure is extremely low. The diagram above shows how hurricane winds blow in an anticlockwise manner in the northern hemisphere.

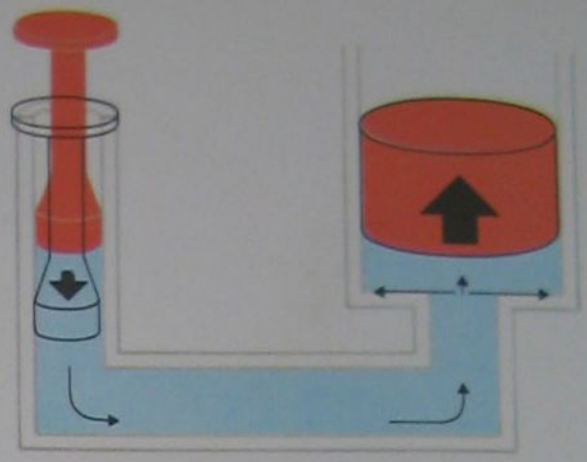
Below: A hurricane in full force blowing over the sea-shore in Florida, U.S.A.

kinds of presses, lifts and brakes.

All hydraulic devices depend upon principles of physics called the *laws of fluid mechanics*. These are divided into the laws of flowing liquids, known as *hydrodynamics*, and the laws of stationary liquids, known as *hydrostatics*.

Many hydraulic machines depend upon the fact that liquids, unlike gases, do not compress when pressure is applied. Instead, they transmit the pressure evenly to all the surfaces of their container. As a result, a small force applied at one point in the system can create a greater force at another point, where the surface area is greater. This principle was discovered by Blaise Pascal in the 1600's, and it is called *Pascal's Law*.

A dentist's chair is an example of a machine based on Pascal's law. Its mechanism consists of a closed system, filled with oil. When the dentist pulls the handle, pressure is applied to the smaller of two cylinders. This pressure is transmitted through the oil to the larger cylinder where it exerts a proportionately greater force. If the second piston is five times the size of the first, it will exert five times the force. Thus, the heavy chair can be lifted. But the distance the chair moves will be five times shorter than the distance the handle is moved, and the dentist must pull several times to lift the chair a few inches. Hydraulic machines of this type have great power, but work slowly.



The above diagram illustrates the principle of hydrodynamics. The force applied to the smaller piston will be increased when it is transferred to the larger piston. The increase in the force will be in proportion to the relative sizes of the pistons. By this principle, a man can lift a heavy car using a hydraulic jack.

Hydrochloric acid (HCl) is a strong acid made by dissolving hydrogen chloride gas in water. It is colourless, and has a very pungent, irritating odour. If it comes into contact with the skin it burns. The gastric juices of the stomach contain small quantities of HC1. If the juices are produced in too large quantities they can cause ulcers.

Since hydrochloric acid dissolves rust better than most other acids, it is used widely in metal industries to clean iron and steel. It is also used in other industries. Tanneries use it, and so do manufacturers of dyes, medicines, explosives and many other kinds of chloride compounds.

To prepare hydrochloric acid, chemists burn hydrogen gas in the presence of chlorine or treat common salt with sulphuric acid. Hydrochloric acid is sometimes called *spirits of salt*.

Hydro-electric power From early days, man has harnessed the energy of falling water for power. He used it first to turn water wheels at flour mills. The wheel turned the grindstones which ground the grain into flour.

Today, we use the modern version of the water wheel—the *turbine*—to turn a generator which produces electric power. This power is called *hydro-electric*, 'hydro' meaning water. One of the largest hydro-electric schemes yet attempted is in the Snowy mountains of Australia, involving nine power stations.

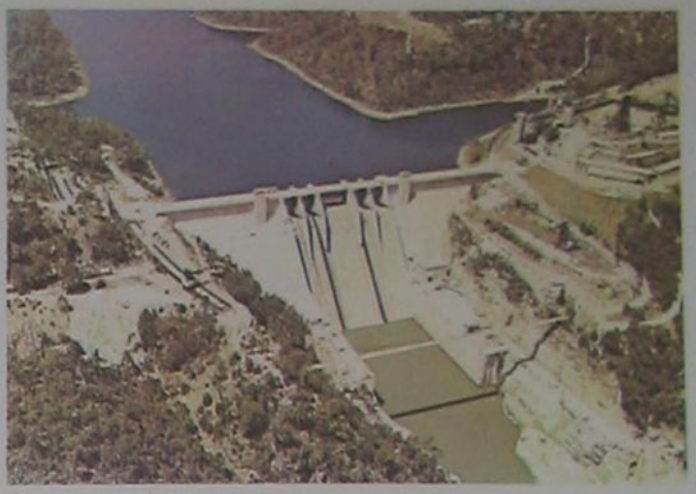
Hydro-electric power stations are usually built in the hills and mountains where there is a natural fall in the water supplying the power. Usually, however, the fall and quantity of water are not great enough to provide sufficient power

and the river is blocked or *dammed*, to raise the height, or *head*, of the water. The artificial lake that forms behind the dam is called a *reservoir*. (See Dam.)

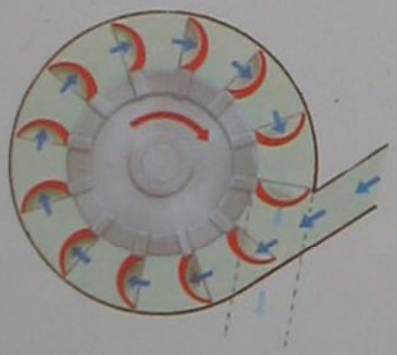
The turbines and the generators driven by the falling water are situated in a *powerhouse* below the dam. Water flows from the bottom of the dam (where it is under great pressure) into the turbines through giant pipes called *penstocks*. The dam has an overflow channel, or *spillway*, to prevent water rushing over the dam and damaging the dam itself and powerhouse.

The great advantage of the hydro-electric power station is that its 'fuel' —water—is free. But the main disadvantage is that it must be situated where the 'fuel' occurs, and this is often in the mountains, many miles away from the factories which consume the electrical power. Consequently, costly transmission lines must be built and maintained.

One solution is for the factories to move near to the power station. Aluminium smelters often do this because they need vast quantities of electricity.



Above: A dam constructed for the generation of hydro-electric power by harnessing the flow of water to the power station turbines.



Above: The Pelton wheel, a simple turbine which revolves because of the pressure of water from the reservoir behind a dam pushing against the buckets.

Right: A sectional view of a hydro-electric dam. Water at the base of the dam is fed to the turbine under great pressure. There it transfers much of the energy to the blades of the revolving turbine wheel. The shaft of the turbine is connected with the generator, producing electricity. Once the water has passed from the turbine it is fed back into the river below the dam.

Hydrofoil Ships expend a lot of power overcoming the *drag*, or resistance, of the water. The hydrofoil boat is designed to reduce this drag greatly. As a result, it can travel much faster than an ordinary vessel. The Russians played a leading part in hydrofoil development.

The hydrofoil itself is a device like an aircraft wing, or *aerofoil*. When it travels through the water, it tends to lift, just as an aircraft wing tends to lift when travelling through air.

The hydrofoil boat has hydrofoils near the bow (front) and stern (rear). It is powered by a screw propeller like any other boat. As the boat gathers speed, the aerofoils gradually lift it further and further out of the water, until the hull is clear.

The only parts of the boat actually causing drag are the struts above the foils. This means that the boat can travel very fast, but makes little wash.

There are a number of different hydrofoil designs. Some are in the shape of a V. Some have a number of foils one above the other, like a step-ladder. In another type, the angle at which the foil goes through the water can be varied.

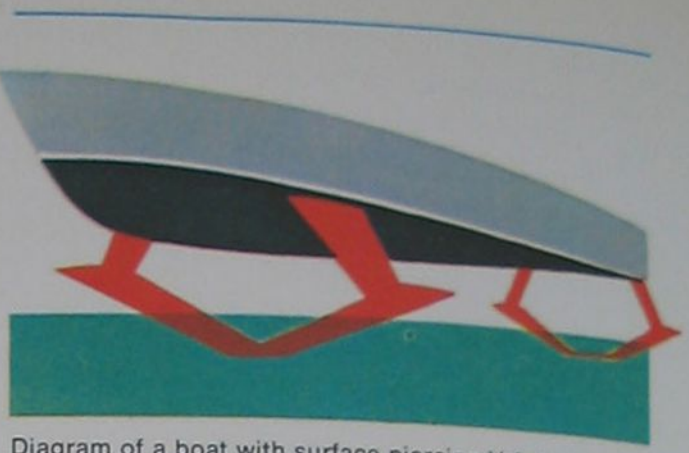


Diagram of a boat with surface piercing V-foils at bow and stern.

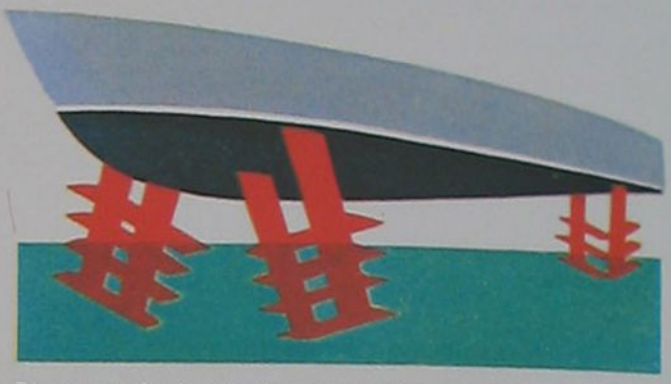


Diagram of a boat with step-ladder foils at bow and stern.

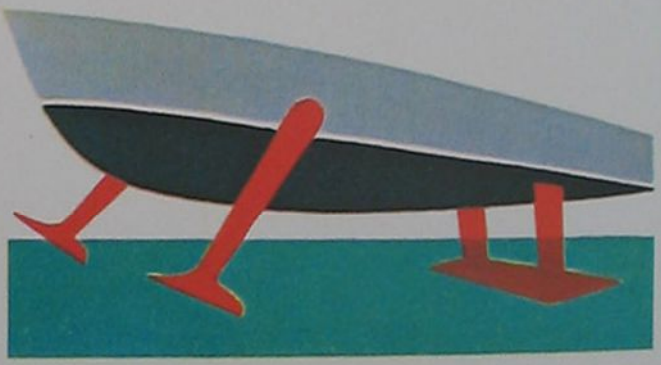


Diagram of one type of incidence-controlled foil system.

Hydrogen is the lightest of all gases. It is twice as light as helium, the next lightest gas, and fourteen times lighter than air. As a result, it is used to inflate balloons. The drawback of using hydrogen, however, is that it burns readily.

Hydrogen is a common chemical element. Water is a combination of hydrogen and oxygen. Petroleum and natural gas are mainly mixtures of hydrocarbons, which contain only hydrogen and carbon. Hydrogen is the chief element found with carbon in the organic compounds which make up living things.

Hydrogen is very reactive chemically. When it burns, it combines with oxygen to form water and produces a lot of heat. It is therefore an excellent fuel. It forms a good proportion of the coal gas produced for cooking and heating in the

Below: A hydrofoil craft skimming across the sea at high speed—the craft is lifted above the water on the foils.

home. Some of the most powerful rocket engines use liquid hydrogen as fuel.

In the chemical industry, hydrogen is extremely valuable. It is combined directly with nitrogen to form ammonia, which is made into fertilizers and nitric acid. Vegetable oils are changed into fats when they are treated with hydrogen. This process of *hydrogenation* is used in the petroleum industry, too.

Hydrogen occurs in more than one form in Nature. With ordinary hydrogen there is a small amount of heavy hydrogen, or *deuterium*, which is twice as heavy as normal hydrogen. Deuterium is used in the incredibly destructive hydrogen bomb. *Tritium*, an artificial form of hydrogen three times as heavy as normal is also used in the bomb.

Hydrogen is the most abundant material in the universe and also the lightest. It is highly combustible and will explode if ignited in the presence of oxygen.

A spotted hyena—one of the two main types of this scavenging mammal. Despite its dog-like appearance the hyena is more closely related to the cat family.

Hyena The hyena is a flesh-eating mammal that is famous for its 'laughing' cry. Hyenas are scavengers—that is, they feed on carrion, the remains of dead animals left by other flesh-eaters. They have extremely strong teeth and jaws, with which they can crack open bones and eat the marrow.

There are two main kinds of hyenas: the striped hyena of southern Asia and north-eastern Africa and the spotted hyena of Africa south of the Sahara. They live singly or sometimes in small groups.

Hypnosis is a state of trance, somewhat like a deep sleep, which can be brought about by the power of suggestion. When a person is put into this state by a hypnotist, he or she will obey orders given, or may even carry out these orders after being awakened.

Hypnosis can be used to cure people of certain emotional problems, and surgical operations have been carried out on a hypnotised person without the use of normal anaesthetics. There is no clear proof, however, that people can be made to do things that are not in their nature under hypnosis. For example, it has not been established that an honest man can be made into a criminal by being hypnotised. Not every one can be hypnotised, and no one has ever explained hypnosis satisfactorily.

In the 1700's scientists first began to investigate the causes and effects of hypnosis. It was also during this period that charlatan doctors used it to convince their patients of their powers of healing. An Austrian doctor call Franz Mesmer discovered some of the potential of hypnosis in curing illness, but he shrouded his work in quasi-religious mysticism and claimed that his successes were brought about by something he called 'animal magnetism'. Hypnosis was not properly explained until the late 1800's. One of its successful modern uses is stopping people from smoking.

I

Ice Ages At least twice during the world's history, there have been periods of intense cold. Winds grew sharper, snow fell endlessly, and great sheets of ice spread slowly outwards from the North and South Poles. For hundreds of thousands of years these ice sheets, called *glaciers*, covered much of the Earth. Canada, northern Europe and Siberia were blanketed with ice, and the Earth's surface underwent many changes.

The most recent of those periods is called the *Great Ice Age*. During this period, the glaciers advanced and retreated four times. When the ice was present, many kinds of plants and animals died out completely. Food was scarce. Great migrations took place; animals travelled long distances, seeking warmer climates.

During the so-called *interglacial* periods, when the Earth grew warm again, animals new to Europe came north from tropical regions. There were hippopotamuses in English rivers, and lions and hyenas in the woods.

The Great Ice Age may have ended 10,000 years ago, with the latest glacial retreat. But it is not certain that there will never be another such endless winter. Ice sheets up to 8,000 feet thick still cover portions of Greenland and Antarctica.

During the great Ice Ages the level of the oceans went down by as much as two hundred feet because of the large amount of the world's water supply that was 'out of circulation'. Modern Man was developing in the last stages of the Ice Age about ten thousand years ago. In this period, mammoths, woolly rhinoceroses, great cave bears and giant Irish deer lived in Northern Europe. Early Man would have hunted them for their meat and for their hides, which he made into warm clothing. It is thought that hunting contributed to their extinction as well as the retreat of the ice.

The map above shows the ares of the world covered with ice during the Great Ice Ages. Only animals that could develop great resistance to the intense cold could survive, like the woolly rhino shown here (right).

Icebergs are large floating masses of ice found in the seas around the North and South Poles. They are formed where *glaciers* (rivers of ice) meet the sea. As the glacier moves slowly forward, pieces crack off and float away, forming icebergs. Icebergs may be many miles long and weigh millions of tons. They may rise 400

Many glaciers reach down to the sea in the Arctic and Antarctic. The huge chunks of ice which break away from them form icebergs.

feet above the sea. But this part is only the tip of the iceberg. The iceberg is seven to ten times as big again under the water.

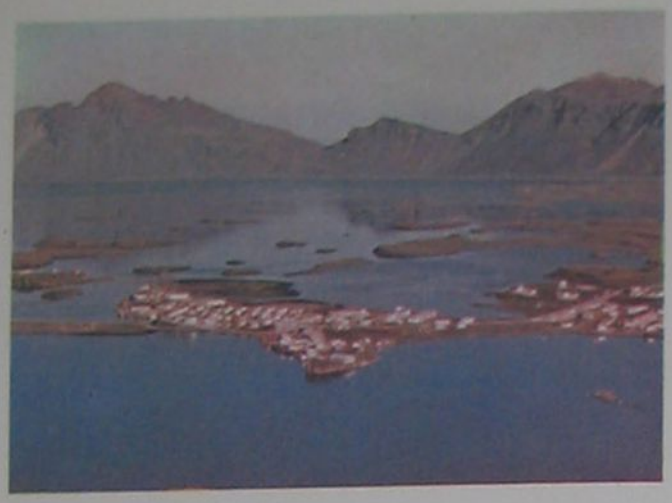
Icebergs form in the North Atlantic Ocean off Greenland, and in the seas around Antarctica. In the North Atlantic, some drift south on the Labrador Current towards the shipping lanes connecting Europe and North America. Here the icebergs meet warm water and melt. In the summer, when more icebergs are formed, ocean ships have to take a more southerly route to avoid them. A collision with an iceberg can be disastrous. In 1912, the liner *Titanic* struck an iceberg on her maiden voyage and sank with 1,500 passengers and crew. The International Ice Patrol now keeps a watch for icebergs.

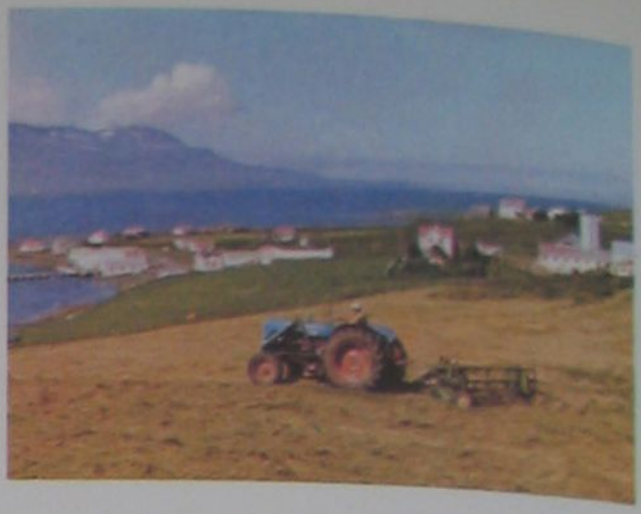
Ice hockey is a fast, exciting game that has evolved from field hockey. It is thought that it was first played by British soldiers serving in Canada. Today it is Canada's national sport.

Ice hockey is a team game, similar to field hockey, that is played on an ice rink. It is especially popular in Canada and the United States, but is also played in northern Europe and the U.S.S.R. The game is played between two teams of six players who carry curved wooden hockey sticks and wear ice skates. The object of the game is to shoot the *puck* (a rubber disk measuring three inches in diameter and one inch thick) into the goal of the opposing team.

The size of an ice hockey pitch can vary, but professional games in North America are played on an ice rink 200 feet long and 85 feet wide. The goals are made of metal mesh and are four feet high and six feet wide.

Ice hockey has the reputation of being the fastest team game in the world. It is also a very tough game and the players wear protective padding on their shins, knees, thighs, elbows and shoulders. The game is controlled by a referee, who is assisted by two linesmen and other officials. It is the only sport in which substitutes are allowed to come on when play is in progress.





Above: A typical Icelandic scene. Right: A farm on which land cultivation is carried out with the use of modern equipment.

Facts and Figures
Area: 39,768 square miles.
Population: 204,300.
Capital: Reykjavik.

Iceland is an island in the North Atlantic Ocean. It lies just south of the Arctic Circle and about 500 miles north-west of the British Isles.

Most of Iceland is a *plateau* (high plain) with lowlands in the south. Rivers flow to the sea from the snow-capped mountains, where ice-fields and glaciers cover the land. Volcanoes and hot springs called *geysers* are active in Iceland.

Although Iceland lies far to the north, its harbours seldom freeze in winter because the North Atlantic Drift, an extension of the warm Gulf Stream, flows near Iceland. Iceland's chief animals are reindeer, mink and seals. Birds include the eider duck, whose feathers are used to fill pillows and eiderdowns. Fish in the seas around Iceland provide the people with food and their main industry – fishing and fish freezing and canning.

Most Icelanders live in the south and enjoy a high standard of living. Some have central heating with radiators filled with water from hot springs. Frozen and canned fish, wool and sheepskins are the chief exports. Farmers rear cattle, sheep and horses. Horses are used for transport in the hilly areas. Only a small part of Iceland is cultivated. In 1972, Iceland banned all trawlers except her own from fishing within 50 miles of the coast. As this area is the main cod fishing ground of the North Atlantic, British fishermen ignored this order.

Iceland is sometimes called 'the Land of Frost and Fire'. This is because glaciers lie next to volcanoes and hot springs. Water from the hot springs is carried by pipelines to the towns, where it is used to provide central heating for people's houses. Iceland has a rich history and the sagas (epic poems) tell the stories of the sea-roving Vikings. Among them was Eric the Red who discovered Greenland. Iceland came under Danish rule in 1380 and it did not gain full independence until 1918.

An early map of Iceland. Iceland was discovered by Irish seamen in the 9th century and was settled by Norwegian Vikings soon afterwards. The map shows seals, whales and mythical sea-creatures.